ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXXII, No. 10.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK.... 183, 197
Solid Floor System, Ben Venue Bridge, Pittsburg, Pa. (illustrated)..... 184
Tests of Materials for Fire-Proofing Buildings.... 184
The San Ellerino-Saltino Rack Railway (illustrated) 184
The Use of T-Rails for Street Railway Tracks.. 185
The Interstate Commerce Statistician's Sixth Annual Report 186
The Experts' Report on the Proposed Hudson River Bridge at New York..... 187
The Bates Hydraulic Dredge on the Chicago Drainage Canal (with inset)..... 190
Cross-Sections of Railway Roadbeds (illustrated). 196
PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS 191
EDITORIAL NOTES 192
The Report of the Experts on the Proposed North River Bridge—Cantilevers and Suspension Bridges—The Importance of Good Track—Liability of Cities for Fire Losses Caused by Inefficient Water Supply—A Curve Diagram as an Addition to a Railway Profile.
EDITORIAL:
Civil Engineers in the U. S. Navy..... 193
LETTERS TO THE EDITOR..... 193
The Theory of Resilience—The Lincoln Trestle Disaster on the C., R. I. & P. Ry. (illustrated).
CONSTRUCTION NEWS 198-202
Railways, Street and Electric Railways, Elevated Railways, Highways, Bridges and Tunnels, Water-Works, Artesian Wells, Irrigation, Sewers, Streets, Electric Light and Power, Miscellaneous Contracts and Supplies, Condensed List of Contracts Pending with Date of Opening Bids, Contract Prices, Metal Market Prices.
INDUSTRIAL NOTES..... 201
STOCK AND BOND MARKETS..... 202

The improvement and deepening of the channel of the Delaware River below Philadelphia are being discussed by the Councils of that city, and an appropriation of $350,000 is asked for by the Port Wardens. The larger part of this sum would be spent at Schomer Ledge, in digging a channel 600 ft. wide and 26 ft. at low water. At the present time the larger vessels are frequently delayed by insufficient water over certain shoals.

A survey of the proposed routes of the Delaware-Raritan Bay ship canal has been ordered by the Canal Commission, and the survey party is in the field. The report of the commission's engineers, Messrs. N. H. Hutton and L. M. Haupt, indicates the scope of the surveys. One route utilizes the Delaware & Raritan Canal, and passes thence to Lawrence Creek and the Raritan River and Bay; this route has the advantage of a maximum cutting of only 52 ft., but crosses the Pennsylvania railway. The other route generally follows the Pennsylvania Railway to Monmouth Junction and then joins the other route; but this line has maximum cutting of 90 ft., and presents difficulties of water supply to offset its non-interference with the railways. Both plans contemplate locks, perhaps two of 25 ft. lift, each at or near the ends. The Delaware and Raritan rivers must probably be depended upon for a water supply to the canal. Mr. Haupt estimates the cost of construction alone at $12,500,000. This does not include cost of right of way.

The Illinois & Mississippi Canal, better known as the Hennepin Canal, is intended to furnish a shorter water route to the Chicago markets for all the towns on the Mississippi River above Rock Island. It will save nearly 600 miles in distance over the present route by way of the Illinois River. The canal will leave the Mississippi at the mouth of Rock River, follow up this stream for some distance and then cut across the country to near Hennepin on the Illinois River; thence the route passes by the Illinois River to La Salle and reaches Chicago by way of the Illinois and Michigan Canal. After the Chicago Drainage Canal is completed it will be substituted for the last named link in the route. At present a channel 80 ft. wide and 9 ft. deep is contemplated; but provisions will be made for widening and deepening this when that is thought expedient. It will be a lock canal with a feeder leading to the summit level from Dixon, on the Rock River. Under an appropriation in the last river and harbor bill, work will be commenced very shortly on the first 4-mile section, which is estimated to cost about $400,000, exclusive of bridges. The total length of the route proposed, from the Mississippi River to Hennepin, is about 70 miles.

The elevation of the tracks of the New York Central & Hudson River R. R., from 106th St. to the Harlem River, is quietly progressing. This work, over about 1½ miles of track, is made necessary by the government requirement of 24 ft. clearance at high water, under the bridge over the Harlem ship canal. The new viaduct will be made of steel and iron, supported upon three lines of columns, from 106th to 138th St., and a masonry viaduct from the latter point to the Harlem. The Elmira Bridge Co. and the New Jersey Steel Co. have the contract for the metal work, at about $1,500,000. The total estimated cost is about $3,200,000, of which the city of New York is to pay $850,000. At the present time two double track trestles are about completed, from 106th to 115th St., to take the traffic during construction. At 115th St. the trains will again take the present tracks, running under temporary wooden trusses, which will support the center of the new viaduct until it is built and the traffic is diverted to it; when this is done, the center piers and columns will be built and the wooden trusses removed.

The New York Central & Hudson River Ry. has completed laying the second section of 100-lb. steel rail with which the main tracks of the road will eventually be equipped in place of the 80-lb. rail now in use. The first section, from the Grand Central station, New York city, to Mott Haven, was laid last year; the section just completed is from Spuyten Duyvil to Peekskill.

Two heavy engines for fast passenger service are being built by the Schenectady Locomotive Works for the Boston & Albany R. R. They are intended to haul the Boston & Chicago limited express on the mountain division between Albany and Springfield, where the grades are sometimes as much as 85 ft. to the mile. The cylinders are 19 × 24 ins., and the driving wheels 5 ft. 9 ins. diameter. The boiler is of the extension wagon-top type, and is built to carry a working pressure of 180 lbs. per sq. in. It is 60 ins. diameter, and has 298 tubes, 2 ins. diameter and 11 ft. long, while the firebox is 90 ins. long and 40 ins. wide, giving a grate surface of about 25 sq. ft. The weight of the engine is 118,000 lbs. with a weight of 74,000 lbs. on the driving wheels. As the road does not use track tanks, the tender is of unusually large size, the tank having a capacity of 4,000 gallons.

The most serious railway accident of the week was a rear collision on the West Jersey Ry. at Camden, N. J., Sept. 2. An excursion train from Atlantic City was stopped by a danger signal, and the rear brakeman had started back to flag an excursion train from Ocean City when the signal was lowered and the engineman whistled for the flagman to come back. Just as the train started it was run into by the Ocean City train. Two persons were killed and a number were more or less injured. It is stated that the operator at the rear of the block in which the accident occurred gave the Ocean City train a "track clear" signal without waiting for the operator at the other end of the block to notify him that the train had passed onto the next block.

A flimsy wooden trestle or footway forming an approach to the Fairmount Park show grounds at Kansas City, Mo., and crossing about 12 ft. above a dry creek, gave way under a crowd Aug. 26. About 75 people were thrown to the ground and over 20 were injured, some seriously.—A 30-ft. highway bridge near Fairbury, Ill., gave way under a traction engine and threshing machine Aug. 24, and one man was killed.

Collisions on suburban electric railways where high speeds are maintained are becoming unpleasantly frequent, and are due generally to lax discipline, the men trying to reach the next turnout to that at which they have been ordered to wait to pass another car. In a collision of this kind at Whiting, Ind., Aug. 27, one man was killed and eight were injured.

Heavy floods have caused great damage to property, and the loss of over 100 lives, in southwest Texas. The town of Uvalde was almost destroyed by the flood in the Leona River. Several miles of track and a number of bridges on the Southern Pacific Ry. have been washed out.

A fire in the coal mine of the Oregon Improvement Co. at Franklin, Ore., caused the death of 37 men on Aug. 24.

Extensive forest fires have prevailed in several states during the past few weeks, and in Minnesota the fires have caused the loss of between 600 and 1,000 lives, have swept several small towns out of existence and have caused immense loss of timber and property. The Forestry Division of the U. S. Department of Agriculture estimated that in 1893 the forest fires covered 12,819,295 acres of wood land and destroyed 473,387,000 ft. of log timber. The most harmful avoidable waste of our timber resources comes from losses by fire. Not only are enormous quantities of timber killed or deteriorated in valleys by the annual conflagrations, but by the burning of leaf mould and seedlings the ground is made barren and given over to inferior vegetation and scrub, and desirable reforestation is prevented. It would be in the interest both of lumbermen and of communities to stop this waste, and it is time that the government adopted a definite policy of forest protection and conservation.

The derelict schooner "Fannie E. Wolston," abandoned Oct. 15, 1891, was encountered and reported for the 44th time Aug. 6. The hull was still in good condition, but with masts, houses and bulwarks gone. This vessel has now been afloat 1,025 days, and has drifted at least 8,575 miles through the Atlantic in that time, as shown by the reports.

The Canadian government has decided to excavate a 16-ft. channel through Lake St. Louis, leading from Lachine wharf, in Montreal, to deep water. The estimated cost is $300,000.

The Navy Department trial of breech mechanism for the new naval small arm is postponed until October. This is done with the hope that more American inventors may respond. The Navy Department has also adopted cast steel shells for the 13-in. guns, for all purposes, except the piercing of armor. They are much cheaper than forged steel and carry 60 lbs. of explosive, which would be very effective against the sides of light-armored ships. Proposals for furnishing these shells have been asked for from five firms equipped for their manufacture.

The breaking of ocean records by the Cunarders "Campania" and "Lucania" is becoming monotonous. On Aug. 31 the "Lucania" reached Sandy Hook Light ship in 5d. 8h. 38m. from Daunt's Rock, off Queenstown. She thus lowered the record for a westward passage 51m., on a total course of 2,787 knots, and made a daily average for five days of 535.2 knots. The average rate per hour was 21.66 knots. On the same day the "Campania" finished the eastward voyage from New York to Queenstown in 5d. 10h. 47m., beating her previous best eastern voyage of Oct., 1893, by 1h. 20m. The average hourly speed was 21.5 knots over a 2,814-knot course.

The new torpedo boat "Ericsson" on Aug. 31 completed its 3,500-mile trip from the builders' yard in Dubuque, Iowa, to this port. The boat left the yard on Aug. 8, and proceeded down the Mississippi River to New Orleans. From there she went to Key West and took the inland passage through Florida to Charleston, S. C. From the latter point she steamed up the Atlantic coast to New York and New London, at which latter place she is to be tested. The temporary propellers used on the Mississippi were knocked to pieces by driftwood, and one of the bronze propellers put in place at New Orleans was damaged by a floating timber in New York Harbor. Otherwise the torpedo boat stood its long trip in excellent shape.

The "Hibernia" is claimed to be the fastest river boat ever built. With the stream a speed of 29 miles an hour is recorded, and a speed of 20¼ miles against the stream. This boat was constructed by Messrs. Simpson & Strickland, at Teddington, England, from the designs of Mr. G. F. G. De Vignes. The general dimensions are: Length, 48 ft. 3 ins. over all; beam, 7 ft. 3½ ins.; draft, 1 ft. 4½ ins.; depth of propeller below the water line, 2 ft. 5 ins. The engines have two high-pressure cylinders 7⅛ ins. diameter, 6 in. stroke, and make from 750 to 1,050 revolutions per minute. At full speed this boat raises an enormous swell, and the owners of house boats along the river object to having these lifted up on the banks and left there.

The bascules of the Tower Bridge in London, says an English paper, were lifted 311 times in 15 days of July to pass 375 vessels. During this period the daily average of people passing over the bridge was 80,000, and 6,400 vehicles passed over in an average day of 16 hours.

One of the piers of the new Memphis bridge across the Mississippi River, the second from the Tennessee shore, is reported by the "Commercial Appeal," of Memphis, Tenn., as showing some slight settlement. The crack extends upward through eight courses of masonry, and in four courses the stones are broken. But those in charge report it as nothing serious.

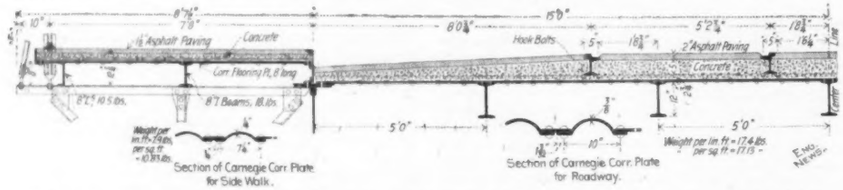
A 16-in. submerged water main broke at Perth Amboy recently in about 10 ft. of water. The main is laid beneath the Raritan River at a point where the latter is about 2,000 ft. wide and 35 ft. deep at its deepest point, the current being swift in the main channel. The main is a part of the new works recently built by the city. During repairs the city was supplied from the reservoir connected with the old works.

Electrolysis of water and gas mains in Newark, N. J., is to be remedied by the street railway companies by methods to be agreed upon between experts selected, one each, by the companies and the Board of Public Works.

SOLID FLOOR SYSTEM, BEN VENUE BRIDGE, PITTSBURG, PA.

We illustrate herewith the solid concrete and corrugated steel plate floor for the Ben Venue Bridge, constructed in 1893 to carry the electric railway and street traffic of Millvale Ave. over the Pennsylvania R. R. tracks at Pittsburg, Pa. This bridge is a deck trestle with 25-ft. towers and 50-ft. spans, excepting the span across the Pennsylvania tracks, which is 118 ft. long. The roadway is 30 ft. wide between curbs and provides for two street railway tracks. There are two 8-ft. sidewalks, carried by brackets outside of the trusses. In designing the bridge a uniform load of 125 lbs. per sq. ft., and the excess loads coming from electric cars and a 15-ton Aveling & Porter steam road roller, were assumed. The material is all soft steel of from 60,000 to 68,000 lbs. tensile strength. In addition to the solid floor, provisions were taken to make the structure extra stiff laterally by using the main trusses as stringers in addition to the usual I-beam stringers carried by the floor beams, and by using no adjustable laterals or cross braces.

The character of the solid floor system used is quite clearly shown in the illustration. Carnegie corrugated steel plate sections are used for both the sidewalk and roadway flooring, and to these on the roadway the 9-in. girder rails for the street railway are attached directly by hook bolts. Upon the corrugated plates is a bed of elastic "binder" in two layers, used to insulate the ironwork and prevent its use as a ground for the return electric current of the street railways. To further the same end, the electric connection between the rails is insulated by being surrounded by asphalt. On the top of the "binder" is placed a layer of concrete, carrying the pavement of Neuchatel asphalt. To provide for contraction and expansion, joints have been made in the concrete at intervals of 25 ft. The asphalt is, of course, continuous over these joints. It is stated that this construction has been found to work satisfactorily during the hot weather of the present summer.


Asphalt Paving
Concrete
Hook Bolts
Asphalt Paving
Concrete
Corr. Flooring Pl. 8' long
8" I Beams, 18 lbs.
5'0"
Section of Carnegie Corr. Plate for Side Walk.
Section of Carnegie Corr. Plate for Roadway.
Weight per lin. ft. = 17.4 lbs. per sq. ft. = 17.13 lbs.
Eng. News.

SOLID CONCRETE AND CORRUGATED PLATE FLOOR SYSTEM, BEN VENUE BRIDGE; PITTSBURG, PA.

The total cost of this bridge was $65,000. The contractors for its construction and erection were the Schultz Bridge & Iron Co., of Pittsburg, Pa., Mr. A. L. Schultz, Chief Engineer, to whom we are indebted for the drawings from which our illustrations have been prepared.

TESTS OF MATERIAL FOR FIREPROOFING COLUMNS.*

On June 13, 1893, a test was made, under the auspices of the Building Department of Vienna, to ascertain how far ordinary brick masonry was capable of protecting a loaded wrought iron column from the effects of fire and water. The test piece was a column made of two channels 11 ft. 5¾ ins. (3.5 m.) long, latticed and connected by plates at the top and bottom. The channels were 5½ ins. deep, 5-16 web, with flanges 2⅜ ins. wide and 7-16 in. thick. The ratio of least diameter to height was about 1 to 25.

The column was encased throughout its length in a square pillar of masonry 18½ × 18½ ins., built of standard Vienna bricks, 11 7-16 × 5½ × 2 9-16 ins., laid in Chamotte mortar. The interior of the column was left hollow and in it were placed, in clay cups lined with gypsum, 13 different alloys for measuring the temperature, the alloys having their melting points at from 65° to 900° C. These pyrometers were so distributed that the lowest one was 39⅜ ins. (1 m.) above the base of the column.

This masonry pillar was then placed in the middle of a rectangular compartment, about 8 × 12 ft. and the same height as the column, with three walls 11 13-16 ins. thick and one wall 29 9-16 ins. thick, covered by a double arch roof built of I-beams and hollow bricks. Two chimneys in the ceiling, about 5 ft. high, served as outlets for the smoke. At each end of this compartment was a door. In order to apply the load in such a manner that the dead weight of the roof and chimneys would be eliminated, a lever was used, resting on I-beams immediately over the center of the column. The masonry encasing the column was also unloaded. The two arms of the lever were 4 ft. 11 1-16 ins. and 18 ft. 9-16 in. (1,500 and 5,500 mm.) long, the short arm being securely fastened by rods running through and anchored at the base of the thicker wall. The load applied at the column was 31,880 lbs. (14,460 kg.), producing a calculated stress in the extreme fiber of about 14,000 lbs. per sq. in. The masonry around the column was finished five days before the test, and to accelerate drying, a mild fire was kept up through the preceding day and night.

The doors referred to above were lined with plates of plaster-of-paris. One door was fixed; the other could be opened to permit additional fuel to be thrown on and to regulate the draft. To serve the latter purpose one of the chimneys was also partially covered. According to the programme, the firing was kept up for 2½ hours. Wood was used and was first built up all around the pillar and later piled up on the side towards the opening door. The glowing pile was held about 3 ft. 4 ins. high, and during the last hour, before water was applied, the fire was forced. A 14-HP. fire engine with 656 ft. of hose attached was used, and the stream of water was not applied until the full pressure had been reached, in order to get the maximum effect.

The combined action of fire and water created the greatest disturbance in the enclosure, through the cracking, breaking and tumbling down of different materials being tested, and which thereby proved their poor fire-resisting qualities.

Notwithstanding the cooling effect of so powerful a stream of water, an examination could not be made until the next day. It was then found that in the masonry built around the column the edges had sprung off, leaving surfaces 1¼ to 1½ ins. wide. In the upper part the bricks were cracked, the mortar partially washed out and the masonry saturated throughout its depth; in the lower part it was, however, dry, and generally it held together.

The iron column, and even the paint upon it, were perfectly preserved; the alloys in the interior indicating that the temperature had hardly reached 65° C. This was, moreover, borne out by the fact that the lever did not show any appreciable movement during the fire test. The temperature in the enclosure was measured by alloys placed in a corner thereof, and protected against the action of water by being encased in steel. They indicated a temperature of 400° C., which must, however, be taken as the minimum.

It is thus proved by this test that ordinary brick masonry, one-half as thick as would have been required for stone masonry, was capable of entirely protecting the wrought iron column during the 2½ hours through which the fire lasted.

As to the behavior of the other materials, the following record is given: Gypsum plates were used as a lining on the two doors, and as a covering on the beams in the ceiling, but the latter fell off very soon, not being sufficiently well attached. The lining of the doors, about 1 9-16 ins. thick, held well until evaporation commenced. One door soon gave way when the water was turned on; it fell and, lying on the ground, was entirely drenched. Gypsum plates cannot, therefore, be recommended as an effective protection for iron construction.

The hollow bricks in the roof and both chimneys were much damaged in places where the water had penetrated through the joints. During the process of cooling the material around the first row of holes had broken off in places. That the entire roof did not fall in was evidently only due to the fact that it did not carry any load. While the hollow bricks showed a better record under this than under other fire tests, the results were such as to make extreme caution advisable in using them for this purpose. The rest of the masonry, laid in Portland cement, remained entirely capable of sustaining the load, as far as could be judged without tearing it down.

To test different kinds of stone, several test pieces were placed in the enclosure, as well as in the surrounding walls. Thus a portion of the thicker wall, 29½ ins. wide and as high as the wall, 11 ft. 5¾ ins., was faced with Schattauer clinkers. On both sides and in a height of about 9 ft. above the floor were inserted stepping blocks of Gmynder granite and Rekowinkler sandstone, projecting about 27½ ins. In the opposite wall were 24 pieces, 11 13-16 × 11 13-16 × 11 13-16 ins., of strong white, yellow and blue Gmynder granite blocks, laid in eight rows; then eight paving stones of thick, fine-grained granite of local varieties; then four blocks of red porphyry flush with the wall. In other parts of the wall were 25 different kinds of stone projecting beyond the face of the wall. Furthermore, blocks of Gmynder granite 6 ft. 2 13-16 ins. long, resting at each end on two similar stones, and other blocks of fine-grained Monthausner granite were placed along the walls and at a distance of 7⅛ ins. from the pillar. All stones had been previously dried.

The natural stones, especially when so placed that they became enveloped by the flames, proved entirely unreliable. Those not destroyed by the flames were damaged and destroyed by subsequent evaporation. The sandstone blocks broke off during the first hour, and the stratified stones peeled off in layers. The granite blocks were not much better preserved at exposed places; the fine-grained varieties especially crumbled under the action of fire and water. The 6-ft. 2 13-16-in. block was cracked very early in the fire test, but it held together until the end of the fire. After cooling, both this block and the four supports showed deep cracks. The granite blocks placed in the wall and flush with its face also showed cracks and scaled off, but no such far-reaching disturbances were apparent as in the pieces exposed for their full length. The four porphyry blocks were entirely destroyed and had fallen out of their places, although they were in a relatively protected position.

While in granite and porphyry the change was characterized by cracking, the calcareous stones failed mainly through changes in composition; the surface frequently becoming very brittle, while the interior remained sound.

In considering the behavior of the natural stones, it should not be forgotten that they were subjected to few or no exterior forces during the fire, otherwise the results would evidently have been still more unfavorable. In the case of clinkers, the damage was limited to fine vertical cracks, hardly noticeable, and reaching a depth of 1 3-16 ins. to 2 ins. When this material is used merely as a lining, such cracks are of no importance. The case would be quite different, however, if the clinkers were used to support a load. The action of a load is to produce similar cracks, and the effect of fire and water would thus combine to increase the action of the load. Further tests of loaded clinker masonry, and also of the Monier construction, will probably be made in the near future.

* Translated by O. J. Marstrand, M. Am. Soc. C. E., from the "Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines."

THE SAN ELLERO-SALTINO RACK-RAILWAY, WITH TELFENER RACK.*

By Julian Edward Caccia.

There are several mountain railways in Italy constructed on the principle of simple adhesion, with grades as steep as 6 or 7%, and there are many on the cable system combined with the rack-rail. The San Ellero-Saltino Railway is the first constructed there with the central rack only. In 1892, the Italian government granted to Count Joseph Telfener a concession of 90 years' for its construction; and the work, begun in the middle of May, was completed and the line was opened for traffic on Sept. 25, 1892, in four months after its commencement. It is intended almost exclusively for tourist traffic.

* From a paper presented to the Institution of Civil Engineers.

Starting from San Ellero, 366 ft. above sea-level, on the Rome-Florence Railway, about 17 miles from Florence, the line ascends the ridges of Prato Magno to Saltino, 3,131 ft. above sea-level, a total length of 5 miles. The sharpest curve on the line is 196 ft. radius, and the steepest gradient 1 in 4.55 (22%). The gage is 1 meter. There are four stations, provided with loop sidings, and 30 grade crossings, of which 1 is on the Valdarnese provincial road, 3 are on municipal roads, and 26 are on private ways. The rack along these

Fig. 1. Telfener Rack Rail; San Ellero-Saltino Ry.

crossings is covered by an iron plate, which the guard is ordered to open and close. The width of rolling stock is 6 ft. 6 ins. The width at sub-grade of both cutting and embankment is 10 ft. 6 ins. The ties rest on 6 ins. of coarse ballast, which is covered with finer material. The width of the ballast is 8 ft. and its total depth is 1 ft. 6 ins.

The difference between this and other lines which have been constructed on this principle is the rack-

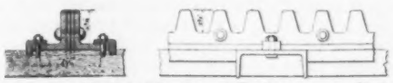


Fig. 2. Modified Design of Telfener Rack Rail.

rail itself, the invention of Count Joseph Telfener. Rack-rails have been made of cast iron (Blenkinsop system); wrought iron ladder arrangement (Marsh or Riggenbach system); and steel rack-bars (Abt system); or, as used on the Mount Pilatus Railway, a double row of vertical cogs, milled out of solid steel bars. The Abt rack was, of course, a great improvement on the Marsh or Riggenbach system, owing to the difficulty and cost of accurate construction of the ladder-rack, although this system possesses greater lateral strength

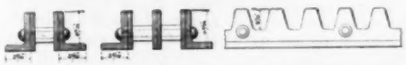


Fig. 3. Modified Design of Telfener Rack Rail.

and stiffness. The Telfener rack-rail, Figs. 1 to 4, is much like the Abt, but cheaper and simpler in construction. It is of Siemens-Martin steel, made at the Ougree Works, in Belgium. It consists of two angle-irons with steel bars between them. The number of the latter is adjusted according to the grades, so that it may not be subject to more than a specified strain, and forms a compact rack-rail. The rack is in lengths of 4 ft. and 6 ft. for adaptation both to curves and tangents, Fig. 4. On lengths where the grade does not exceed 12%, the rack is formed of two angle irons riveted together, Fig. A, Fig. 1. On lengths with grades over 12% and up to 22%, the rack has the same angle irons, but in addition two intermediate plates or bars, the four thicknesses being riveted together, Fig. B, Fig. 1; so that, besides giving to the toothed line greater resistance in these lengths, it increases the width of the teeth, and by that means a greater gearing space is obtained, which is especially desirable on sharp curves. The angle irons are 4⅜ ins. high, 7⅛ ins. wide and 11-16 in. thick. The intermediate rack plates are 4⅜ ins. high and 9-16 in. thick.

This rack-rail may be also strengthened in the following ways: (1) By giving a greater height to the intermediate plates and grooving them into the ties, as

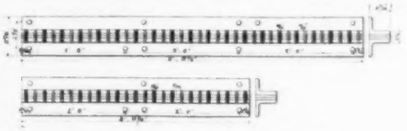


Fig. 4. Plan of Telfener Rack Rail.

in Fig. 2; or (2) the angle irons and plates, instead of being close together, may be placed with a certain space between, using tubular distance pieces and obtaining by that means a double or triple rack, as in Fig. 3. This rack has the disadvantage that it cannot be placed in steps as in the Abt system, but the wheel is larger, and therefore able to grasp three teeth at a time. It was specified in the contract that the plates of the rack should have a resistance of 31 to 38 tons per sq. in., and a shearing-strain of 15%. It was also required that each tooth of the compound rack-rail should support a weight of 78.73 tons on an incline of 22%. To test this, the machine shown in Fig. 5 was used. The cost of the rack complete is approximately, per lin. yd., $3.26, which is considerably less than that of either the Riggenbach or the Abt rack.

The track complete, is shown in Fig. 6. The rack-rail rests on longitudinal timbers, placed on the transverse oak ties which support the two Vignoles rails, and attached to them by means of lag screws 10 ins. long, passing through both the longitudinal timber and the underlying ties. The rails weigh 40 lbs. per yd. There are 13 to a rail length of 20 ft. 6 ins. where the grade is under 10%, and 15 where the grade is over 10%. Further, to insure the line from slipping in lengths where the grade exceeds 10%, there are "creep-arresters," consisting of substantial posts, at distances

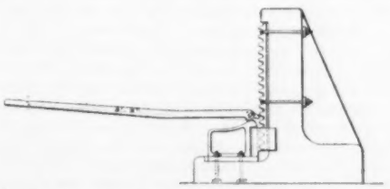


Fig. 5. Machine for Testing Teeth of Telfener Rack Rail.

of 88 ft., resting against the ties and driven 3 ft. 6 ins. into the ground.

The trains run at 5½ miles per hour on grades up to 15% and 4⅓ miles per hour on grades from 15 to 22%; so that the entire length of line, 4.97 miles, is traversed in 57 minutes.

The cost of construction of the line was as follows:

Rack-rail	$32,825
Rack-rail, expenses of transport and laying	2,200
Rails	19,005
Ties, 13,000 at 42 cts.	5,680
Longitudinal timber	1,280
Earthwork	7,000
Masonry work and stations	12,000
Girder-bridge over the Vicano	1,400
Ballast	1,600
Sundries	2,000
Engineering, administration, etc.	5,000
Total cost of construction	$90,000

The small cost of the line (about $18,110 per mile) is due to the absence of tunnels, and also to its having been possible to introduce curves of 198 ft. radius.

THE USE OF T-RAILS FOR STREET RAILWAY TRACKS.

A number of street railways are now using T-rails and girder rails for their tracks, the rails having either plain or grooved heads. At Saginaw, Mich., the street railway company applied to the council for permission to use a T-rail, and, as there was much difference of opinion in the council, and protests were made by property owners against the use of such a rail, the council appointed a committee, consisting of Mr. Joseph B. Staniford and Mr. R. W. Roberts, City Engineer, to investigate the practice in other cities. The company's franchise

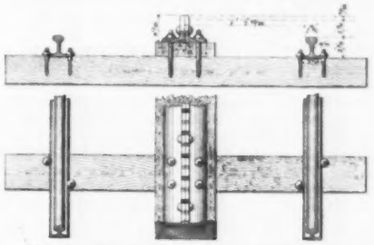


Fig. 6. Track of San Ellero-Saltino Ry.

puts the question of the kind of rail to be used wholly within the power of the Board of Public Works. The substance of the committee's report is as follows:

Port Huron, Mich.—All street-car tracks are laid with a 45-lb. T-rail, ordinary railway section, laid on a 5 × 5-in. longitudinal pine stringer, laid on ties spaced 3 ft. c. to c. The space on the outside of the rail, between the rail head and flange, is filled with a 2 × 2-in. pine strip, and the pavement laid against it, the top flush with the top of the rail. On the inner side of the rail the space is filled with a 2 × 2-in. oak strip, laid about 1-in below the top of the rail, and the pavement laid against it, and crowning to the center between rails to the top of rails.

Where the track was laid in the new pavements, and in conjunction with the laying of the pavements, the pavement is in good condition, and the T-rails offer no obstruction to the free use of vehicles of that part of the street occupied by railway tracks. Where the tracks were laid in the old pavements, the pavement between the tracks is rough and rutted along the rail, so that in many places it is dangerous to turn out of the track when driving upon it, though it offers no more obstruction on crossing the track than in crossing

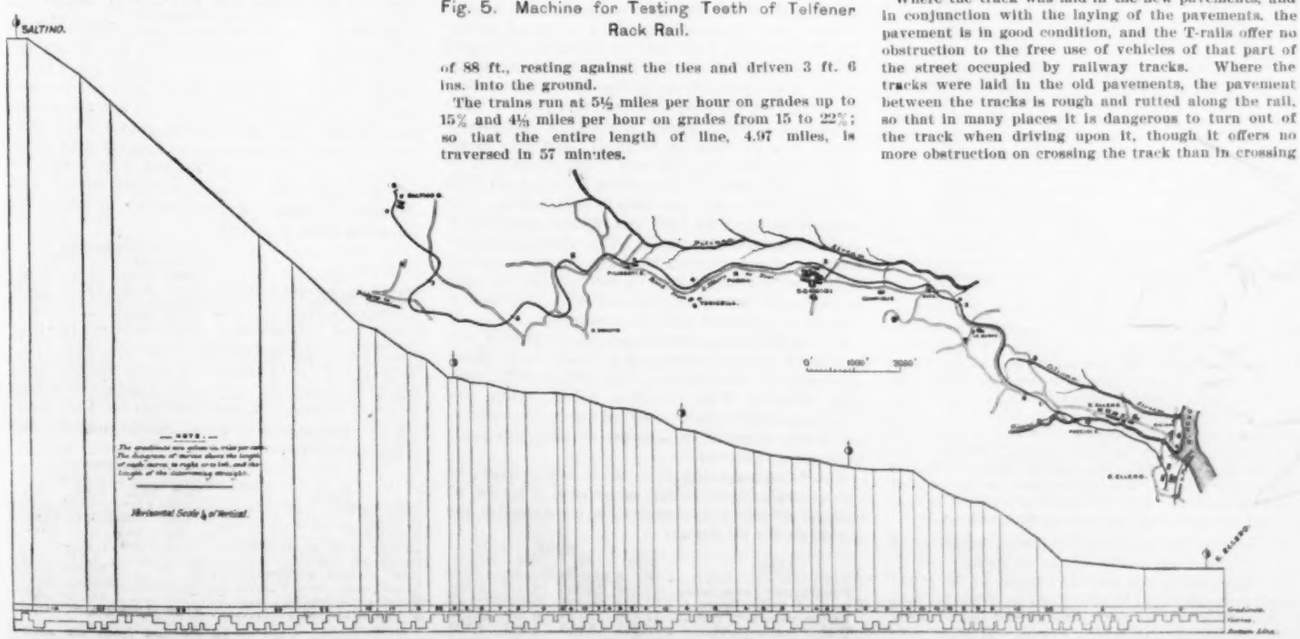


FIG. 7. MAP AND PROFILE OF SAN ELLERO-SALTINO RY.

many other parts of the same part of the street. The tracks are in good condition for a rapid transit street railway system.

Detroit, Mich.—Prior to 1892 all street-car tracks were laid with the flat-top rail, either of girder or strap section, but on May 27, 1892, the following ordinance, providing for grooved girder rails, was passed and adopted:

Section 1. It is hereby ordained by the people of the City of Detroit, that whenever any street railway track shall hereafter be constructed or reconstructed on any paved street, or on any street then being paved or repaved, the same shall be laid with girder-grooved rails. Said rails shall not be of less than 77½ lbs. weight to the lineal yard, and of improved pattern and style, with groove on inner side of the rail, the upper surface of the inner head of the rail to be not more than ¼ in. below the upper surface of the outer head of the rail. All work shall be done under the supervision of the board of public works.

Under this ordinance the 77½-lb. grooved rail has been laid in parts of Woodward Ave., Gratiot Ave., Michigan Ave., and Champlain St., in conjunction with the paving of those streets and avenues with asphalt, brick, granite and cedar block pavements, with no special care to fit the pavement close against the web of the rail. The pavement is laid close against the head or tread of the rail, and the space against the web filled with cement grouting. The rail is 6¼ ins. high and 4 ins. wide, laid on tie-plates spiked to white oak ties, laid about 3 ft. c. to c., and the rail is connected every 8 ft. with cross rods 1 × 1½ ins. in size, to preserve the gage of the track, which is very important with this section of rail. This section seemed to offer but very little obstruction to the use of the street for vehicles.

Toledo, O.—The rails used in this city for street car lines are the common flat top rail with a tram 1½ ins. wide, and the pavement is generally laid level with the top of the rail, which forms a groove on the tram of the rail 1½ ins. wide and 1 in. deep, which makes it very objectionable for public travel.

Columbus, O.—All the street-car tracks in this city are laid with the flat top rail with narrow tram, except a short piece of groove girder-rail, just laid in repairing the track on one of the principal streets. This section is about the same shaped groove and top as the Detroit section, and is 9 ins. high and weighs 90 lbs. per yd. The flat top rail generally in use is a girder-section weighing 46 lbs. per yd., laid on chairs to elevate the rail above the pavement foundation, but this section is found to be too light to stand up under electric motor cars, and is being replaced by a 70-lb. rail of the same section except that it is 6¼ ins. deep. An ordinance has recently been passed by the council of the city granting a suburban electric line the right of way through the paved streets of the city, and the board of public works and city engineer have given permission to use a T-rail, the space on the outside of the rails to be paved closely with paving brick.

Springfield, O.—All the street car lines in this city are laid with the T-rail section, except a few blocks of the old flat rail originally constructed for horse car lines. Most of the rails used are the ordinary railway T-rail section, weighing 50 lbs. per yd. One street, which is now being paved, and a street car track being laid in it, is being laid with the electric welded T-rail known as the Johnson street railway T-rail, weighing 62 lbs. per yd. The T-rail tracks laid in this city are laid in paved and dirt streets. When laid in brick pavements the bricks are laid close to the head of the rail on the outside of the track, level with the top of the rail and between the rails ½-in. below the top of the rail and crown to the center of the track, level with the top of the rail. On dirt and gravel streets the space between the rails and along the outside of rails is filled with dirt and gravel, the same as the rest of the street. There is no planking or paving between the rails on unimproved streets. All the T-rail tracks in this city are in good condition both for the street car company and the public using the streets, and the T-rail where laid in brick pavement offer as little obstruction to the use of the public to drive upon or across as any section of rail in use.

Chicago, Ill.—All the street car tracks in this city are laid with the girder-rail 5 to 6 ins. high, with a 3-in. wheel tram. This width of wheel tram is specified by the Commissioner of Public Works for all street car tracks. This width of tram is adopted to prevent the wheels of heavy loaded wagons from cutting a rut along the inside of the rail. The street car tracks are used for driving upon, the same as any other part of the street, as the streets are generally crowded from curb to curb with buggies, wagons, carts and street cars, so the paved portion of the street is all occupied and it is necessary that the street car tracks be constructed like tram roads as well as for street cars.

The conclusions presented by the committee as to rails for street car tracks are as follows:

One thing which was forcibly brought to the attention of your committee is that, if the public have rapid transit, which they so much demand and should have, teamsters driving with loaded wagons and other vehicles cannot have the free use of the street car tracks for a roadway, to the detriment and impediment of the street car service; and when the streets are paved as wide as they are in this city, the sooner the public driving carriages and wagons, and vehicles of all kinds are educated to understand that they have no business driving in the street car tracks, except to cross them, the sooner we will have rapid transit, better and more reliable street car service better and smoother street car tracks to ride over.

In the judgment of your committee there are only two sections of rails that should be permitted to be laid in our wide paved streets, and these are the street railway T-rail and the full-grooved or English groove-girder rail. Either of these sections can be used, we believe, with perfect safety, to the public using the street, and if properly laid will make a good street car track.

If the street railway T-rail is used it should be not less than 60 to 70 lbs. per yd. and 5¾ ins. high with the paving brick or blocks shaped to fit close to the web of the rail and ½ in. below the top of the rail on the inside, and level with the top of the rail on the outside. If the grooved rail is used it should weigh not less than 70 to 80 lbs. per yd., and the paving should be fitted close around the head and web of the rail.

While a lighter section of rail than these mentioned may be amply strong for the motor cars now in use, it is only a question of a short time when the lighter sections will be found inadequate in strength to carry the heavy motor cars and loads placed upon them. As the tendency is to use larger, heavier and stronger cars, which will carry heavier loads, and this increased rolling load will at the same time demand a heavier rail and more permanent track to sustain the weight placed upon it, it is necessary at this time to provide a rail section that will be ample in strength and rigidity, not only for the present, but for the future, to prevent the destruction and waste to both the street pavements and the tracks of the street car company, in renewing its tracks.

THE INTERSTATE COMMERCE STATISTICIAN'S SIXTH ANNUAL REPORT.

From the advance sheets of the sixth annual report of the Interstate Commerce Commission's statistician, covering the year ending June 30, 1893, the following facts, figures and deductions may be obtained relating to the railways of the United States:

In its summary of mileage the commission gives 176,461 miles as the total single track for the United States and territories; classing 170,332 as official and the remainder as obtained from unofficial data. This mileage is given by states and includes the number of miles of railway per 100 sq. miles of territory and per 10,000 inhabitants. While both of these latter deductions depend for the separate states upon their relative areas and the density of population, conditions varying widely, the averages for all the states and territories figure as follows: Miles of railway per 100 sq. miles of territory, 5.94; miles of railway per 10,000 inhabitants, 26.51. These figures are based upon an area of "land surface" of 2,970,000 sq. miles and excludes Alaska; and the total population is figured at 66,551,571, allowing 1,250,000 for an estimated annual increase in 1891-92-93, but also excluding Alaska.

The total summary of mileage shows an increase of 2.80% over the corresponding fiscal year of 1892; while the previous report showed an increase of 1.88% over the mileage of 1891. The rate of increase from 1886 to 1887 was 9.08%; from 1887 to 1888, 6.05%; from 1888 to 1889, 3.22%; from 1889 to 1890, 4.78%, and from 1890 to 1891, 2.94%. The commission say that while the railway construction in the year ending June 30, 1893, stands below the average of construction of the previous six years, it is in excess of the rate of increase for the year immediately preceding and probably indicates a turn in the curve of railway construction.

During the year reported upon, the State of Washington led in construction, with 556.32 miles; Montana was a close second, with 409.66 miles, and then followed West Virginia, 365.01 miles, and Texas with 299 miles. Only eleven of the remaining states reported an increase of over 100 miles built during the year.

The following table of totals is taken from the commission's classification, by groups of states, of mileage according to organization for operation for the whole United States:

	Miles.			
Lines.	1890.	1891.	1892.	1893.
Owned directly	99,931	108,733	112,679	113,988
Proprietary companies	13,926	14,386	13,806	15,281
Operated under lease	27,724	26,553	22,234	21,608
Under contract, etc	11,578	7,784	9,732	11,782
Under trackage rights	3,245	3,819	3,946	4,120
Total operated*	156,404	161,275	162,397	169,780

* Single track.

In connection with the total mileage here given for 1893 it should be explained that only the mileage covered by official returns to the commission is used throughout this report as a basis of computation. It represents single-track mileage on June 30, 1893. The total length of track reported to the commission on this date, and including first, second, third and fourth tracks and yard tracks and sidings, was 230,137.27 miles. This table shows that the tendency towards merger, consolidation, lease, traffic agreement and the like is now relatively stronger than the tendency towards railway construction. This tendency is further indicated by other tables in the report, showing an increase of 68 railway corporations in 1893 over 1892; that within the year 28 lines, representing 724 miles of operated railway, were merged; 16 lines, representing 1,711 miles, were reorganized, and 16 lines, representing 1,549 miles, were consolidated with other lines. In 1893 42 operating companies, each with a mileage exceeding 1,000 miles, controlled 98,385 miles of railway, or 55.78% of the total mileage in the United States. Twenty-six corporations operated lines from 600 to 1,000 miles long, and represented 11.20% of the total mileage, and 902 corporations out of a total of 1,034 operated lines under 250 miles in length and covering 18.94% of the total mileage. The commission concludes its summaries under this head by saying that they represent in an imperfect way the extent of railway consolidation, for many lines which are legally independent are for all practical purposes operated under a single management.

The report next takes up the subject of railway equipment on June 30, 1893. The totals are as follows: Passenger locomotives, 8,957; freight locomotives, 18,599; switching locomotives, 4,802; total, including some unclassified, 34,788. There was an increase of 109 passenger and 1,040 freight locomotives in the year. The total number of railway cars reported is 1,273,946, of which 31,384 are assigned to the passenger service, 1,013,307 to freight service under the direct control of the company, and 34,270 to freight service through the agency of fast freight lines; 154,068 cars were leased, for the most part from trust companies, and are represented by equipment thus obligations. Tables given show that the average equipment per 100 miles of line for the whole United States remains nearly stationary at 20 locomotives and 750 cars. From a comparison of equipment with the amount of traffic for the whole country the following table can be made, showing relatively the conditions in 1892 and 1893:

	1892.	1893.
Passengers carried per pas. engine	63,399	68,268
Passenger miles per pas. engine	1,510,273	1,588,601
Tons carried per freight engine	40,239	40,062
Ton-miles per freight engine	5,025,403	5,031,889
Pas. cars per million pas. carried	51	53
Freight cars per million tons freight carried	1,627	1,613

The feature most interesting to the freight employee on the railways of the United States is the extent to which automatic safety devices have been introduced, especially air-brakes and automatic couplers. In March, 1893, Congress passed a law making it obligatory upon carriers to supply their equipment with automatic couplers and train brakes before January, 1898. The commission reports upon the progress made in obeying this law as follows for the years 1892 and 1893:

	Train brakes.			
	Locomotives.		Cars.	
Class.	1893.	1892.	1893.	1892.
Passenger service	8,823	8,705	30,562	28,202
Freight service	14,059	12,572	194,141	100,256
Switching service	2,729	2,244	.....	.....
Leased and unclassified	2,049	1,784	.....	.....
Company service	....	....	3,679	2,756
Fast freight line service	....	....	6,296	4,412
Total owned	....	....	234,678	195,626
Total leased	....	....	86,689	35,938
Totals, equipped	27,660	25,305	271,367	231,564
Totals in service, 1893	34,788	....	1,273,946	.....

A similar summary of the automatic coupler would stand as follows:

	Automatic couplers			
	Locomotives.		Cars.	
Class.	1893.	1892.	1893.	1892.
Passengers	2,640	1,930	30,446	27,923
Freight	655	449	216,923	155,117
Switching	122	143	.....	.....
Leased and unclassified	519	401	.....	.....
Company service	....	....	1,827	1,264
Fast freight service	....	....	12,366	10,503
Total cars owned	....	....	261,562	194,807
Total cars leased	....	....	56,740	46,604
Totals equipped	3,936	2,923	318,302	241,411

The general facts to be gleaned from the above statements are as follows: That on June 30, 1893, out of a total of 8,957 passenger locomotives, 8,823

were fitted with train brakes, and out of a total of 18,599 freight locomotives, 14,059 were so fitted. With regard to automatic couplers, it appears that 2,640 passenger locomotives were so equipped out of the above total, but only 655 freight locomotives out of the 18,599 had automatic couplers. Turning now to passenger cars, we find that out of 31,384, 30,562 have air-brakes and 30,446 have automatic couplers. But with freight cars the record is very different. Out of an aggregate of 1,273,946 cars, only 271,307 have air-brakes and only 216,923 out of a total of 1,013,307 cars assigned to freight service under the direct control of the roads are furnished with automatic couplers. The commission properly says that the railway companies are moving very slowly in this matter of automatic couplers for freight trains. As indicating the types of train brakes and couplers adopted by the railway companies, several tables are given in the report, but they are given without any attempt to classify couplers under the same general type. Among train brakes the Westinghouse shows 287,703 cars equipped out of a total of 299,041. The New York brake comes next with 7,133. Among automatic couplers the Janney shows 102,056 out of a total of 322,238, and then come the Gould, "M. C. B.," Miller, Van Dorston, Chicago, Safford, etc., in the order given. No fewer than 55 automatic coupling devices are named in this list as in use. The use of automatic couplers has increased from 80,510 in 1889 to 322,238 in 1893.

According to the commission's report, the number of men in the service of railways in the United States on June 30, 1893, was 873,602, an increase of 52,187 over the number employed in the previous year. These figures are given with the caution that they are not the average for the year, but the number of men on the companies' pay rolls on the date mentioned. While the annual rate of increase in population is 2.50%, the rate of increase in railway employment during the year covered was about 6%. As the first percentage relates to the entire population and the second to bread-winners only, there is clearly no tendency as yet for the railway industry to lessen its claims upon the laboring population of the country, says the report. Classified by occupation, the railway employees rank in numbers as follows, for June 30, 1893:

General officers	6,610
Office clerks	27,584
Station agents	28,019
Other station men	75,181
Enginemen	38,781
Firemen	40,359
Conductors	27,537
Other trainmen	72,959
Machinists	30,869
Carpenters	41,878
Other shopmen	93,709
Section foremen	29,699
Other trackmen	180,154
Switchmen, flagmen and watchmen	46,048
Telegraph operators and despatchmen	22,619
Floating equipment employees	6,146
Other employees and laborers	105,166
Unclassified	284

The average ratio of men per 100 miles of line under the following heads is thus given: General administration, 21; maintenance of way and structures, 151; maintenance of equipment, 103, and for conducting transportation, 234.

The next subject taken up by the report is that of capitalization and value of railway property, and in this connection the commission truly says that no range of facts in railway accounting is so difficult of accurate statement, owing principally to the reorganizations going on among companies passing through a process of consolidation. Only a few general statements will be attempted here. From the summaries given, for June 30, 1893, it would appear that the total railway capital on that date was $10,506,235,410, showing an average capitalization of $63,421 per mile. Of this total amount $4,698,935,418 are represented by stocks and $5,225,689,821 by funded debt, the latter covering mortgage, real estate and income bonds, and equipment and miscellaneous obligations. As to earning capacity of stocks and bonds, we find that in the year under notice 61.24% of the stock paid no dividends, and 10.93% of the bonds paid no interest. Of dividend-bearing stocks 27.43% paid a rate of from 4 to 8%, and the great bulk of the bonds carry between 3 and 6%.

The following interesting table is given in the report as showing certain general results in the administration of railway property:

Item.	1893.	1892.	1891.	1890.	1889.	1888.
Revenue per passenger per mile.....cts.	2.108	2.126	2.142	2.167	2.165	2.349
Average cost, carrying 1 passenger 1 mile "	1.955	1.939	1.910	1.917	1.933	2.042
Revenue per ton of freight per mile..... "	.878	.898	.895	.941	.922	1.001
Average cost of carrying one ton one mile "	.579	.582	.583	.604	.593	.630
Revenue per train mile, passenger trains....$	1.06.819	$1.06.873	$1.06.111	$1.08.041	$1.06.287	$1.13.952
Average cost of running a passenger train one mile .....cts.	82.948	81.931	80.453	80.984	83.068	84.691
Revenue per train mile, freight trains.....$	1.62.721	$1.64.611	$1.63.683	$1.65.434	$1.65.377	$1.65.712
Average cost of running a freight train 1 mile$	1.06.709	$1.06.196	$1.06.172	$1.05.711	$1.06.481	$1.03.876
Revenue per train mile, all trains.....$	1.43.229	$1.44.649	$1.43.345	$1.44.251	$1.39.191	$1.46.719
Average cost of running a train one mile, all trains .....cts.	97.272	96.580	95.707	96.006	94.868	96.050
Percentage of operating expenses to operating income	67.82	66.67	66.73	65.80	66.81	65.34

During the year covered by the report 2,727 railway employees were killed and 31,729 injured. This is an increase over the previous year's report of 173 under the first head and 3,462 under the second head. The number of passengers killed was 299, and 3,229 were injured. This is 77 less killed and 2 more injured than in 1892. The total number of passengers carried in 1893 was 593,560,612, as against 560,958,211 in 1892; and thus about 1 in 2,000,000 passengers was killed and 1 in about 180,000 was injured. Under the head of "others killed or injured" are included casualties at stations, highway crossings and tresspassers upon the tracks. Under this head are charged 4,320 killed and 5,435 injured during the year.

Then follows a classification of railway accidents resulting in casualties to employees, passengers and others, and a statement of the fatalities due to each kind of casualty sustained by trainmen, switchmen, flagmen, etc. From these tables it appears that of the total 2,727 fatal accidents to railway employees, 433 were due to coupling and uncoupling cars, 644 to falling from trains and engines, 73 to overhead obstructions, 247 to collisions, 153 to derailments, 125 to accidents to trains others than these mentioned, 32 to accidents at highway crossings, 117 to accidents at stations, and 903 to causes not susceptible of classification. A similar statement covers the injured among the employees. Referring to the statistics of accidents for the entire country, it appears that during the year covered one employee was killed for every 320 men employed, and one was injured for every 28 employed. In the more dangerous service, that of conducting transportation, says the report, one employee was killed for every 115 men employed and one injured for every 10 men engaged in this branch of railway service. The greatly reduced risk of the passenger has already been referred to.

The report closes with certain recommendations contained in previous reports relating to the form and method of reports to be made by various companies to the commission. The report is signed by Mr. Henry C. Adams, the Statistician to the Interstate Commerce Commission, and he credits the detail of compilation and the general management of the office to Mr. Stephen C. Mason, the Assistant Statistician.

EXPERTS' REPORT UPON THE PROPOSED HUDSON RIVER BRIDGE AT NEW YORK.

The long experience and professional standing of the engineers making this report, coupled with the very unusual dimensions of the proposed bridges, make their report one of the most interesting and valuable engineering documents that has lately appeared, and we give it practically in full.

This board of bridge engineers was appointed by the President, under an act of Congress, approved June 7, 1894, and its duty was to recommend what length of span, not less than 2,000 ft., would be safe and practicable for a railway bridge across the Hudson River, between 59th and 69th Sts., New York city. The board appointed was made up of Messrs. G. Bouscaren, W. H. Burr, Theodore Cooper, George S. Morison and Col. C. W. Raymond, all well known to American engineers. The board assumed a minimum clear span of 2,000 ft., while the maximum span was the 3,130 ft. between pier line heads at 59th St. The submitted plans of the New York & New Jersey Bridge Co. located the east end of its 2,000-ft. span next to the New York pier-head line, and thus placed the west pier about 1,000 ft. from the New Jersey pier-head line. The board concluded that navigation would not be benefited by a greater clear span than 2,000 ft. unless the span reached from pier-head line to pier-head line. A span of 3,100 ft. would meet all the requirements of a single span. The report continues as follows:

The plans submitted by the bridge companies provide for a cantilever bridge carrying six railroad tracks. This number of tracks is the least that has been proposed by any company which has contemplated bridging the Hudson River opposite the city of New York. Your Board have therefore thought it right to make estimates for a bridge furnishing this accommodation. The fact that the river must be kept unobstructed during erection limits the plans to cantilever and suspension bridges. The plans submitted by the bridge companies provide for a steel cantilever bridge, a description of which is given in appendix H; A cantilever bridge is a rigid structure subject to those changes of shape only which are due to strains; it is well adapted to railroad uses.

In the first place your Board are of the unanimous opinion that a cantilever span 3,100 ft. in the clear could be built and would be a safe structure.

In the second place your Board have considered that the practicability of such a structure would depend upon its cost, and to determine this practicability have made comparative estimates of the cost of two cantilever bridges with clear spans of 2,000 ft. and 3,100 ft., respectively. These estimates are comparative rather than absolute; the benefit of doubt, where any exists, has been given to the longer span. The estimates include both substructure and superstructure, but have been made in round numbers and do not include the cost of tracks and other features which would be common to both plans.

A series of borings, covering virtually the limits permitted by the act, have been made by the bridge companies, under the direction of Mr. C. B. Bush, C. E., at the request of your Board, to determine the character of the bottom of the river. These borings have found rock at varying depths, but as the borings were not extended into the rock, the absolute information before your Board is that no rock exists above the reported elevation rather than that solid rock exists below it; but your Board have considered themselves justified in assuming that it is a substantial rock, suitable for foundations. The borings outside of the limits of the special line considered have confirmed the accuracy of the others.

The depth to rock is about 125 ft. at each pier headline; it is about 260 ft. at the site where the pier of the 2,000-ft. span bridge would come; the rock rises rapidly from each pier headline shoreward. The depth of water at the site of the river pier is about 50 ft. Under the water is a layer of mud, or silt, about 100 ft. deep. Below this mud is a fine sand, filled with fresh water under a pressure exceeding the head due to its depth.

The mud or silt is not a suitable material for the foundation of the bridge piers. For the comparatively moderate weights carried by bridges of usual dimensions, the sand would be a suitable foundation. For the extraordinary weights and dimensions of the bridge authorized by the act, your Board are not satisfied that the piers would be safe unless founded on rock, and the comparative estimates have been made for rock foundations.

The lateral provisions to resist wind, and the longitudinal provisions for stability during erection, require a considerable base. The plans submitted by the bridge companies proposed to use a pier consisting of four cylinders placed 200 ft. between centers in each direction. The total weight, including the effects of wind pressure, carried on each cylinder is estimated at 25,000 tons.

In proportioning these piers your Board have found it necessary to adopt limits of stress. They have based their estimates on the supposition that the pressure between the metallic bedplates and the top of the masonry should not exceed 20 tons to the square foot, and that the pressure within the masonry and on the foundation should nowhere exceed 10 tons to the square foot. They consider, however, that in determining these pressures the weight of the material displaced should be deducted. The weight of masonry per cu. ft. was taken at 150 lbs. in air, at 87 lbs. in water, and 50 lbs. in mud, and at 90 lbs. in sand. While these pressures have been exceeded in some structures, they are higher than usual practice, and call for masonry of good quality and more than ordinary cost.

Your Board have assumed that the masonry would finish 50 ft. above water, and have estimated the cost of these piers, including excavation and sinking, at $1 per cu. ft. above a plane 125 ft. below water, and have added eight mills to this for each additional foot of depth.

The east pier of the bridge, with a clear span of 2,000 ft., would be immediately back of the New York pier headline, where the rock is 125 ft. below mean high water. The west pier would come in the river where the rock is 260 ft. below mean high water. The east anchorage would be within the shore line, where the rock is not more than 20 ft. below mean high water, and the west anchorage would be immediately west of the New Jersey pier headline, where the rock is 125 ft. below mean high water. The site of the west anchorage calls for an anchorage span 100 ft. long as shown on the plans submitted by the bridge companies.

The east pier would consist of four cylinders, each containing 866,000 cu. ft., and costing, on the basis given above, $866,000, making for the four cylinders $3,464,000.

At the site of the west pier the average depth of rock is not less than 260 ft. A foundation carried to rock here would be nearly 100 ft. deeper than any foundation which has ever been put in. Such a foundation involves very careful consideration, and your Board believe that the additional price allowed for so much of

the work as is more than 125 ft. below water is none too large. Each of the four cylinders would contain 1,880,000 cu. ft., of which 1,014,000 would be more than 125 ft. below water, making the cost of each cylinder $2,427,500, and the cost of the four cylinders $9,710,000.

The east anchorage pier would be founded on rock about 20 ft. below mean high water, and the west pier on rock 125 ft. below water. Each of these piers should be estimated on the basis of a pier finishing 150 ft. above high water, 20 ft. thick, and 100 ft. long on top, built with a batter of one in twenty, and founded on a caisson 40 × 120 ft. for the east pier, and 45 × 125 ft. for the west pier. Taking the cost of the work above water at 75 cts. per cu. ft., and of the work below water at $1, the cost of the east pier becomes $431,000, and that of the west pier $1,038,000. The cost of the substructure for the bridge with the 2,000-ft. pier span would be:

East anchorage	$431,000
East pier	3,464,000
West pier	9,710,000
West anchorage	1,038,000
Total	$14,431,000

A careful estimate prepared by the bridge companies makes the weight of the superstructure 230,000,000 lbs., including the main span, the towers, and the two anchorage spans, covering a total length of 4,120 ft. This weight has been checked and may be taken as approximately correct. The plan was prepared for a location at 72d St., where the distance between pier headlines is 3,070 ft. At 59th St. the west anchorage span would be lengthened 100 ft., and if the bridge is kept symmetrical the whole length will be increased to 4,320 ft., and the total weight to about 240,000,000 lbs. This estimate is based on a moving load of 3,000 lbs. per foot of track and on maximum stresses of from 20,000 to 22,500 lbs. per sq. in., or about one-third of the ultimate strength of the material; 240,000,000 lbs., at 4½ cts. per pound, would cost $10,800,000. The cost of this bridge would then be $25,443,000.

This is the cost of a cantilever bridge of the minimum span which your Board are authorized to consider, the length of the entire structure from anchorage to anchorage being 4,320 ft. As this plan of bridge is the one which the New York and New Jersey bridge companies have selected as the bridge they wish to build, its cost must be accepted for present purposes as the cost of a practical structure.

The site of the east pier for the span of 3,100 ft. in the clear would be the same as that for the 2,000-ft. span; the site of the west pier would be the same as that of the west anchorage for the 2,000-ft. span. Both piers would be founded at practically the same depth, or 125 ft. below mean high water.

The weight of the trusses of the long span would be about three times the weight of those of the short span, and the weight of the floor and moving load would be about one and a half times that of the short span. The total reaction on the piers would be at least two and one-half times that of the short span. On this supposition each of the four cylinders would have to carry 62,500 tons.

The piers in both bridges are so large that their volume can be proportioned directly to the weights they have to carry. This would make the volume of each pier of the 3,100-ft. span bridge two and one-half times that of the east pier of the 2,000-ft. span bridge. The estimated cost of the east pier of the 2,000-ft. span bridge was $3,464,000, so that we may estimate the cost of each of the two piers of the 3,100-ft. span bridge at $8,660,000.

The anchorage piers required for the long span bridge need be little larger above the water level than for the shorter span. The anchorage pier on the east side would be on rock about 20 ft. below mean high water; its cost would be about the same as that for the 2,000-ft. span. The anchorage pier on the west side would be on rock 40 ft. below mean high water, and is estimated to cost $527,000. The total cost of the substructure for the 3,100-ft. clear span bridge would then be:

East anchorage	$431,000
East pier	8,660,000
West pier	8,660,000
West anchorage	527,000
Total	$18,278,000

Estimates by this Board show that the weight of the superstructure of this bridge would be approximately 730,000,000 lbs., about three times that of the shorter span bridge; 730,000,000 lbs. at 4½ cts. per lb. is $32,850,000.

The total cost of the 3,100-ft. span bridge, covering a length of 6,100 ft. from anchorage to anchorage, may therefore be estimated at $51,128,000, though this estimate is probably too low.

The estimated cost of the 2,000-ft. span bridge was $25,443,000 for 4,320 ft. To bring it into proper comparison with the longer span bridge, 1,780 ft. of viaduct must be added. Estimating this viaduct at $1,000 a foot, the cost becomes $27,223,000. The estimated cost of a long span cantilever bridge is $23,905,000 more than this amount. Your Board are of the opinion that the additional cost of the long-span cantilever bridge is so great that it must be considered impracticable.

A suspension bridge is another possible form of construction at this location. Like the cantilever, it can be erected without falsework; unlike the cantilever, it has not generally been considered well adapted to railroad uses. It has less rigidity than the cantilever, and deflects more from the combined effect of temperature and load. The flexibility of the cables tends to cause vertical undulations of the platform under a moving load, which are more objectionable for a railroad bridge than for a highway bridge, where the live load is less concentrated and is applied less rapidly. These objections lessen in importance as the span of the bridge and the proportion of the dead to the live load increase.

In a bridge with six independent tracks the condition of railroad service approaches that of highway service, and the position of trains which will produce a maximum disturbance would be of very rare occurrence. The inclination of the platform longitudinally and transversely, arising from the undulations of the cables under the effect of moving trains, can be reduced within unobjectionable limits by a proper system of stiffening; the effect of wind on cables and platform can be taken care of by cradling the cables, and by a lateral system of bracing in the platform similar to that used in truss bridges. A single railroad track suspension bridge of 850 ft. span has been in continuous use, under restrictions of load and speed, for nearly 40 years at Niagara. With this example before us, a six-track railroad suspension bridge of 3,100 ft. clear span cannot be dismissed without careful consideration.

Your Board have therefore investigated such suspension bridge with great care, and it is their opinion that it could be built, and that it would be a safe structure. As this opinion may be thought a departure from general opinion as to the adaptability of the suspension bridge to railroad service, it is proper that the Board should state their reasons therefore, and explain the features of the plan adopted by them for a comparative estimate in more details than was done for the cantilever plans.

The essential differences between a cantilever and a suspension bridge are: First, that in the place of compression chords of the cantilever we have land anchorages built of eyebars and masonry; second, in place of the tension chords of the cantilever we have cables built of wire of a superior grade of metal; third, in place of the web bracing of the cantilever we have a composite system of suspenders and stiffeners.

No question can be raised as to the safe and permanent character of the anchorages if built with a sufficient factor of resistance and proper provisions for thorough protection of the anchor chains against rusting. They have the advantage over the compression chords of the cantilever, that their weight is supported directly on the ground instead of forming a part of the dead load to be carried.

As regards safety and efficiency, the wire cables are fully equal to the eyebar chords, if built with the same margin of strength. Experience shows that they can be effectively protected against rusting by wire wrapping and painting. Wire at least three times as strong as eyebar steel is a merchantable article, and cables made of this wire have the advantage over eyebar chords of less weight to be carried by the superstructure.

The objections made to suspension bridges arise only from the third difference. It is often claimed that a sufficient degree of rigidity cannot be secured for railroad purposes, and that the stiffening members cannot be properly proportioned, owing to the uncertainty which exists in the intensity of stresses due to changes of temperature and elastic deformation in the composite system. The Board have given careful consideration to these objections and believe that for practical purposes they are met in the plan selected.

Three principal methods have been employed to secure greater rigidity in suspension bridges: First, by inclined stays extending from the top of the towers to the platform. This system was advocated and applied extensively by the late John A. Roebling. Second, by trussing the cables either with straight chords, as in the Point Bridge at Pittsburg, or by a system of braces between two cables, as proposed by Mr. G. Lindenthal for his projected North River bridge. Third, by a stiffening girder fastened to the platform and extending from one tower to the other. This system is a feature common to nearly all suspension bridges, but has seldom been applied in the most approved form to give the best results. The first method is at best incomplete, as a stiffening truss must be used for the middle half of the span. The second method might prove the most economical, but its application to wire cables is still untried. Your Board have, therefore, selected the third method, that of the stiffening truss.

The suspension bridge which your Board have selected for this location would consist of a single span of 3,200 ft. between saddles, thus giving about 3,100 ft. in the clear, the two towers being located at the pier headlines and the cables being carried in straight lines from the top of the towers to the anchorages, making equal angles on each side of the towers. This form of bridge has no side spans, but the tracks would be carried on viaducts between the towers and the anchorages. While the use of cables outside the towers to sustain side spans is generally considered economical, the arrangement selected gives the least length of cable and reduces deflection from strains and temperature to a minimum.

The two towers would be located in practically the same position as the towers of the 3,100-ft. cantilever. The substructure would be of masonry, finishing at the same height as the masonry of the cantilever bridge piers. The towers themselves would be of steel, and would be 570 ft. high from top of masonry to saddles, or 620 ft. from surface of water. For towers of this height there is no question of the economy and expediency of using metallic construction. The anchorages would be of masonry, each located about 1,000 ft. back of the towers. Both towers and anchorages would have to be founded on rock.

The cables would be of wire, and the plans have been based on cable containing about 6,000 No. 3 wires (0.259 in. in diameter). Wiremakers are prepared to furnish a wire of this size, of the guaranteed strength of 180,000 lbs. per sq. in., at moderate prices, and a much stronger wire at a higher price. Your Board have adopted as the unit stress on cables made of straight wire of this character 60,000 lbs. per sq. in. of one-third of the breaking stress, this being the same proportion of the ultimate strength that the 20,000 lbs. adopted in the cantilever structure bears to the probable strength of eyebar steel.

Your Board have estimated on a versed sine of 400 ft., or one-eighth of the span. In the East River bridge the versed sine is less than one-twelfth of the span, and about the same as in other long span suspension bridges. In the East River bridge the cables are of steel wire and the towers of masonry. With the introduction of steel towers the economical proportions are changed, and it becomes practicable to adopt a greater versed sine than has hitherto been considered wise.

Stiffening Truss.—There are several admissible forms of stiffening truss. To justify the particular form selected by the Board for their estimate, it is proper to give a short explanation of its duties and mode of action. A stiffening truss is a girder supported by the cable and extending from one tower to the other. It is fastened to the platform at the several points of suspension to the cables, and it may be fastened to the towers in two ways; it may be held in the vertical direction, anchored down as well as supported, and acting as a girder resting on two supports, or it may be fastened also in the horizontal direction, acting as a girder fixed at the ends. The Board have confined themselves to the first case, which has the advantage of greater simplicity in computation of stresses without material sacrifice of economy.

The function of a stiffening girder is to distribute a load covering only a part of the span over the entire span. If this function could be performed without any deformation of the girder, the distribution would be perfect, and the symmetrical shape of the cables would be preserved, but as the girder deflects under the load that it carries, it exerts, through the suspenders, a downward pull on the cables as far as the load extends, and beyond that point the cable exerts a pull upward on the girder. If it is continuous it will take the shape of a reverse curve, with its point of contraflexure at the end of the load. The strain in all the suspenders will be uniform for the whole length of span. The weight to be carried by the loaded portion of the stiffening truss will be the moving load upon it, less that carried by the suspenders. The suspenders over the unloaded portion, where the cable tends to rise, are strained by the resistance of the stiffening truss against flexure upward. The weight per unit of length carried by the suspenders will always be equal to the live weight per unit multiplied by the length of load and divided by the length of span. Over the loaded portion this is the actual weight per unit of length, less the portion carried by the stiffening truss. Over the unloaded portion this represents the upward pull resisted by the stiffening truss. The upward force per unit of length which tends to lift the unloaded portion is therefore the assumed weight per unit multiplied by the length of load and divided by the length of span. The weight per unit of length carried by the stiffening truss on the loaded portion is the total weight per unit of length, less that weight multiplied by length of load and divided by length of span.

When one-half of the span is loaded the weight will be equally divided between suspenders and stiffening truss; the stresses in the chords of the stiffening truss will be one-eighth those caused by the same load extending over the whole length of the span if the truss were not supported by suspenders.

The greatest stresses occur in the continuous stiffening truss when either two-thirds or one-third of the span is loaded. In the former case the loaded portion must carry one-third of the load, and the chord stresses at the middle of that two-thirds will be 4-27 of the maximum stresses at the center of the span if the truss were fully loaded and not supported by suspenders; in the latter case, the chord stresses at the center of the loaded portion will be only 2-27, while the chord stresses at the center of the unloaded portion will be the 4-27, but reversed. As the two-thirds load may be placed anywhere in the truss, it follows that the chord stresses over the whole central third may be 4-27 of the maximum stress at center of span, if the truss were fully loaded and not supported by suspenders. The shearing stresses in the webs of the stiffening truss are determined by the same distribution of loads.

It must be remembered that the only stresses in the stiffening truss are those due to moving load, all dead weight being carried directly by the suspenders to the cables.

While this is the simplest explanation of the duties of the stiffening truss, it does not take into consideration all elements. The downward and upward deflection of the stiffening truss must be accompanied by corresponding changes in the shapes of the cables, but as these changes are in the direction in which the cables would move if no stiffening truss existed, it follows that the weight is not distributed equally among all the suspenders, and the stiffening truss is relieved of resisting so much inequality as is taken by the cables. The elongation of the suspenders is also a slight element of disturbance, but not sufficient to be described here. An analysis of it will be found in Appendix E.

There are two other strains which the chords of the stiffening truss may be called upon to resist. The first of these is due to the deflection of the cables under temperature and under load. As the stiffening truss is not supposed to carry any of its own weight, it must deflect with the deflection of the cables, and this deflection must be accompanied by the transfer of a portion of its own weight to itself with corresponding stresses in its chords, these chord strains being determined entirely by their deflection. The other additional stress is due to wind pressure if the chords of the stiffening truss are made the chords of the lateral system as in ordinary truss bridges.

The greater the depth of truss the less the chord stresses due to its stiffening duty, and the greater the stresses due to deflection of cables. The wind stresses depend on the horizontal distance between the two trusses.

To avoid the strains due to deflection of cables the stiffening truss may be hinged at the center, which can be done by cutting one chord and putting a pin-joint in the other. This arrangement fixes the point of contrary flexure at the center of the span under all conditions of loading, and leaves the stiffening truss free to rise and fall with changes of deflection in the cables without additional strain. As the bending stresses at the center are now eliminated, the only function of the pin-joint will be to transfer the shearing stresses. With the introduction of the hinge and the fixing of the point of contrary flexure, the work of the stiffening truss is modified and the investigation becomes more complicated; it is given in Appendix E. The truss still equalizes the weight on all the suspenders, but the total weight carried by the suspenders is equal to the whole moving load only when that load covers one-half the span. The greater chord stresses in either direction occur at a distance equal to 0.234 of the span from each end, and will be 0.1506 of the maximum stresses at center of a continuous span if the truss were fully loaded and not supported by suspenders.

The maximum chord stress in the hinged truss is, therefore, 1.017 times that in the continuous truss, but it is a maximum only at two points instead of over one-third the span. The continuous truss is better adapted to resist wind than the hinged truss, but its chords have to bear the additional stress due to deflection. As the hinged truss is practicable and more economical than the other, it has been used in the estimates made by your Board.

The form which your Board have selected for a stiffening truss is a riveted lattice girder 120 ft. deep, the two trusses being placed 100 ft. between centers. The web members are all inclined at an angle of 45° and are in eight systems, so that the truss is divided into 90-ft. panels, and the unsupported length of each web member is about 21 ft. The floor beams are hung from the suspenders and carry the stiffening truss, the weight of which is never en-

tirely overcome by the action of the moving load. The top lateral system is a comparatively light riveted lattice. The whole lateral work to resist wind pressure is done by the bottom lateral system, in which the floor beams form lateral struts, and the diagonals are strained in tension. Gross bracing is provided at every panel point to sustain the floor beams at their centers and to transfer wind pressure to the bottom chord, the pull of this chord bracing being resisted by the top lateral system.

Proportioning the trusses for a moving load of 3,000 lbs. per ft. on each of the side tracks, the maximum chord stress at the center of the half-span would be 14,461,400 lbs., and the maximum chord stress in the bottom chord at the center, taken on the basis of a wind pressure of 2,000 lbs. per lin. ft., would be 25,690,000 lbs. As the chords are subject to reversal of strains your Board have limited the stresses in the chords due to moving load to 12,500 lbs. per sq. in. in each direction, making an extreme variation of 25,000 lbs, but have allowed the stresses from the combined effects of moving load and wind to run up to 22,500 lbs., believing that with the arrangement of cradled cables hereinafter described, the wind strains will never be anything like what should be estimated on. They have also estimated on the chord sections never being less than 400 sq. ins. With these conditions the average section of the bottom chord becomes 906 sq. ins., and that of the top chord 995 sq. ins., the two averaging 950 sq. ins. Allowing 25% excess for details, the average weight of each chord will be 4,037.5 lbs per lin. ft.

The average shear in the web system will be 3,000,000 lbs., in addition to which the web system has to do a duty in transferring weight from the upper to the lower chord equivalent to a shear of 1,300,000 lbs. per lin. ft., making the total duty of each web equivalent to an average shear of 4,300,000 lbs. If the web is proportioned on the basis of 12,500 lbs. per sq. in., with an allowance of 50% for details and connections, the weight of each web becomes 3,569 lbs. per lin. ft.

The calculated weight of the top laterals is 500 lbs. per lin. ft. The calculated weight of the bottom laterals, on the basis of 25,000 lbs. stress per sq. in., with an allowance of 25% for details, is 1,150 lbs. per lin. ft., making total weight of laterals 1,650 lbs. per lin. ft.

The floor beams weigh 90,000 lbs. each, or 3,000 lbs. per lin. ft. of bridge. The stringers weigh 1,800 lbs. per lin. ft. of bridge. Floor beams and stringers for a consolidated locomotive, weighing, with tender, 104 tons. The total weight of the suspended superstructure per lin. ft. may then be taken as follows:

	Pounds.
Four chords, at 4,037.5 lbs.	16,150
Two webs, at 3,509 lbs.	7,018
Laterals	1,650
Cross frames and hangers	1,920
Floor beams	3,000
Stringers	1,800
Total steel per lin. ft.	31,538

This amounts to 100,921,600 lbs. for the 3,200 ft. of span. If to this we add 2,400 lbs. weight of the ties and rails and 18,000 lbs. for moving load, we have as the total weight carried by the suspenders 51,938 lbs., or 26 tons per lin. ft.

This stiffening truss is a very different structure from the stiffening truss of any existing bridge. It is what it purports to be, a stiffening truss, with a heavy floor system like that used in the cantilever design, and with stiff connections throughout. This stiffening truss, 3,200 ft. long, with its floor system, weighs two-fifths as much as the entire 4,320 ft. of steel work of the 2,000-ft. cantilever bridge.

Suspenders.—The suspenders would be either wire ropes or cables of straight wires like the main cable. They have been proportioned on the basis of a stress of 30,000 lbs. per sq. in. of section, and on this basis, with an allowance of 20% for connections, will weigh 1,425 lbs. per lin. ft., making the whole weight transferred to the cables, 53,363 lbs. The suspenders weigh 4,560,000 lbs. for the 3,200 ft.

Cables.—The average weight of the cables will be 14,792 lbs. per lin. ft. of bridge. The total weight to be carried by the cables may therefore be taken at 63,100 lbs. per lin. ft., amounting to 217,920,000 lbs., or 109,000 tons for the span of 3,200 ft. The versed sine assumed is 400 ft., or one-eighth of the span. The greatest strain in the cables will be next to the saddles, and will be equal to the weight carried multiplied by 1.118, amounting to 243,724,000 lbs., which, at 60,000 lbs. per sq. in., will require 4,062 sq. ins. Six thousand No. 3 wires have a total area of 316 sq. ins. The 4,062 sq. ins. may be divided into 12 cables of 338.5 ins. each. Your Board believe that these cables can be constructed now as easily as those of the East River bridge were at the time it was built.

The arrangement of cables which has seemed most feasible to your Board, and which has been used for the basis of these estimates, places six cables on each side, the cables being 20 ft. apart on top of towers, the two cables next to the center on each side being in vertical planes and the other cables cradled into planes which intersect in the lines of the pins which sustain the floor beams. A separate suspender reaches from each pin to every cable, the suspenders being in the same planes as the cables.

Vertically the cradling of the outside cables is 100 ft. in a height of 469 ft., or one in 4.6. Horizontally it is 100 ft. in a total length of 3,200 ft., so that the horizontal cradling of the two outside cables is 200 ft. in 3,200 ft., or one in 16. A sufficient cradling is obtained not only to resist the entire wind pressure on the cables, but to relieve the lateral system very materially. The distance between the cables will favor simultaneous construction. The suspenders at each point will be of uniform length and will pull together. The length of the suspenders at the center of the span must be enough to allow the cables to clear each other where the attachment is made, and this places the lowest parts of the cables 60 ft. above the pins. The total height of the towers above high water is made up as follows:

	Feet.
Clearance required by law	150
Camber	10
Shortest suspender	60
Versed sine	400
Total	620

The total length of each cable from anchorage to anchorage is 5,009 ft. The weight of each of the 12 cables per lin. ft. of cable, including wrappings, is 1,183 lbs. The weight of the 12 cables is 14,200 lbs. per lin. ft., and the total weight of the cables 79,647,800 lbs.

Towers.—The weight transferred by the cables to each tower is 218,000 lbs. The towers are 570 ft. high from top of masonry to saddles. As these towers are only in compression and the members so large that they may be treated as short compression members, a stress of 20,000 lbs. per sq. in. at the top is permissible. This requires 10,900 sq. ins. of section. The weight of each tower, with an allowance of 80% for details and connection, would be 38,023,560 lbs., or 76,047,000 lbs. for both towers. The total weight to be carried on the lower part of the tower would be 128,000 tons, making a pressure of less than 24,000 lbs. per sq. in. at the base of the steel columns, which will be very slightly increased by the wind pressure and by the horizontal deflections at the top of the towers if the saddles do not move freely.

Anchor Chains.—The cables are carried in straight lines from the saddles to the anchorages, each anchorage being on two parts, each part anchoring the six cables in its side of the bridge. The upward pull of the cables at each anchorage (one side) is 54,500,000 lbs., and the horizontal pull, 109,000,000 lbs. The estimates have been made on the basis of connecting the cables with the anchor bars outside of the masonry of the anchorage, placing these anchor bars in tunnels, and connecting them with bearing plates at the lower ends. Everything would be accessible for care and repairs. The chains would be of steel eyebars, which have been proportioned for a stress of 20,000 lbs. per sq. in., with an allowance of 20% for details. The estimated weight of the bars and pins in each of the four half anchorages is 6,825,000 lbs., while the plates at the bottom would add 600,000 lbs. to this amount, making the total weight in each half anchorage 7,425,000 lbs., or 29,700,000 lbs. in the four.

Structural Steel.—In estimating the cost of the structural steel work your Board used the same price per pound as for the work in the cantilever bridge, namely, 4½ cts. On this basis the cost would be as follows:

	Pounds.
Suspended superstructure	100,921,600
Towers	76,047,000
Chains	27,300,000
Anchor plates	2,400,000
Structural steel	206,668,600
At 4½ cts.	$9,300,087

The majority of the Board believes that this price is too high, owing to the difference in character of steel work in the two structures, and that the total cost of the structural steel work should not be estimated higher than $8,500,000.

Wirework.—The cables and suspenders have been estimated at 8 cts. per lb., making their cost:

Cables	(pounds)	79,647,800
Suspenders	"	4,560,000
Total wire	"	84,207,800
At 8 cts.		$6,736,624

Superstructure.—The total cost of the superstructure is $16,036,711, on the basis of ½ cts. for all structural steel.

Substructure.—The substructure would consist of two anchorages and the bases for two towers. Each tower base has to carry the following weights:

	Tons.
Suspended weight on top of tower	109,000
Tower	19,000
Extra effect of wind	4,000
Total	132,000

Each of the tower bases of the 2,000-ft. cantilever bridge carries 100 tons. In both cases the foundations can be made proportional to the weight carried. The east tower is in the same place as the east pier of the cantilever bridge. The cost of this base for the suspension bridge tower will be that of the cantilever bridge pier, or $3,464,000, multiplied by 1.32, making $4,572,480.

The west tower would come immediately west of the New Jersey pier headline, the average depth of rock being about 10 ft. more than on the east side, requiring 414,000 cu. ft. additional in the foundation. Estimating on the same basis as for the west pier of the cantilever bridge, the cost of this 414,000 cu. ft. of foundation would be $431,000, which would make the cost of the west tower base $5,003,480.

The anchorages have been planned on the basis of putting the entire weight which is to resist the pull of the cables above mean high water; and the quantities have been based on a co-efficient of friction of 0.6 and a factor of safety of 2. The anchorage at each end of the bridge would contain 5,940,000 cu. ft. above the foundation. The only duty of the anchorage is to act as weight, and a very cheap class of masonry can be used for this purpose; rubble made of the most available stone, with a facing of rough ashlar or brick, would do. The cost of this masonry may be estimated at 37½ cts. per cu. ft., although the Board believed it could be built for much less. On this basis the cost for each anchorage above mean high water is $2,227,500.

The east anchorage would be founded where the rock is 20 ft. below mean high water; the foundation could be put in with a cofferdam, and has been estimated as costing 75 cts. per cu. ft. There would be 1,150,000 cu. ft. in this foundation, making the cost $862,500, and the total cost of the east anchorage $3,090,000.

The foundation of the west anchorage would have to be sunk 60 ft. to reach the rock, and would probably be put in by the pneumatic process. Its volume would be three times that of the east anchorage, and its cost may be estimated at the same price per cubic foot, or $2,587,500, making the total cost of the west anchorage $4,815,000.

The total cost of the substructure would then be: East anchorage, $3,090,000; base for east tower, $4,572,480; base for west tower, $5,003,480; west anchorage, $4,815,000. Substructure, total, $17,480,960.

The anchorages can be adapted to carry the tracks, but the tracks must be carried between them and the towers on viaducts, requiring 925 ft. of viaduct on each side, or 1,850 ft. in all, which has been estimated at the same price as before. The total length of the suspension bridge, including viaducts and anchorages, is 5,600 ft. The total cost will be as follows: Superstructure, $16,036,711; substructure, $17,480,960; total, $33,517,671; viaduct, $1,850,000. Grand total, $35,367,671.

The estimated cost of the 2,000-ft. cantilever bridge was $25,443,000 for 4,320 ft. To compare it with the 5,000-ft. suspension bridge, 1,280 ft. of viaduct must be added. This makes the cost $26,723,000. The estimated cost of the suspension bridge is $8,644,671 more. The fairest comparison is by percentages; the cost of the suspension bridge is nearly 32½% more than that of the 2,000-ft. cantilever bridge. If allowance is made for cost of structural steel in accordance with the views of a majority of the Board, the difference will be reduced to $7,844,584, or nearly 30%. The general conclusion which your Board have reached is that the cost of a suspension bridge of a single span, designed for its whole length for the same moving load as the 2,000-ft. cantilever bridge would be less than one-third more than that of the cantilever.

Deflections.—The structure described is one of unusual rigidity. The expansion of the metallic towers counteracts in a degree deflections due to elongations of cables under an increase of temperature, this deflection being further reduced by the large versed sine. Of the 34 tons per lin. ft., only 9 are moving load, so that the stress per square inch on cables caused by a maximum moving load is less than 16,000 lbs.; it would not exceed 5,000 lbs. with an ordinary freight train on every track, or 2,500 lbs. with a passenger train on every track. The deflections have been calculated for a full moving load with the following results:

Conditions.	Effect of
60 degrees F.	— + 2 cable between towers.
Max. moving load.	— 2.75.
	— + 0.1 back stays.
	— 0.14.
	— + 0.22 towers.
	— 0.11.
	— + 0.03 suspenders.
	— 0.02.
	— + 1.91 total.
Combined,	— 3.02.
	— 4.75.
	— 0.24.
	— + 0.11.
	— 0.05.
	— 4.93.

In other words, the total deflection at the center of the span below a mean is about 5 ft.; the deflection above a mean is less than 2 ft.; the total range is less than 7 ft. These deflections are within satisfactory limits for railroad service.

A deflection of 5 ft. in a length of 3,200 ft., calculated for a modulus of elasticity of 28,000,000 lbs., corresponds to a chord stress of 7,870 lbs. per sq. in. in a stiffening truss 120 ft. deep. This is the stress which has been eliminated by the use of the hinge.

Lighter Structure.—The calculations of the cost of the suspension bridge, which has been described, have been made as nearly as possible on the same basis as the estimates for the cantilever bridge, without taking into consideration the fact that the cantilever bridge would be strained nearly to its full capacity by a load 1,000 ft. long, while the suspension bridge would be fully strained only when covered by a load three times that length. Furthermore, no allowance has been made for the fact that the maximum strains in the stiffening truss would occur only under combinations which might not arise once in a century, and which could be prevented by simple police regulations.

A moving load of 3,000 lbs. per ft. 1,000 ft. long, on each of the six tracks, crossing the bridge without change of relative position, would produce practically maximum effects in upward movements on a continuous stiffening truss, but it would produce only one-half these movements downwards. In other words, the chords of the stiffening truss would be strained 12,500 lbs. per sq. in. by upward bending, but only 6,250 lbs. by downward bending, on the assumption as before that all the moving load is distributed by the stiffening truss; as only about 88% is distributed by reason of the unsymmetrical deflection of the cable, the maximum chord stresses are reduced and become respectively 11,000 and 5,500 lbs. The greatest upward deflection from the action of the cables occurs from the effects of temperature when the bridge is unloaded; under a full load it is eliminated, and under a 1,000-ft. load it is reduced to about 1 ft., which corresponds to a chord stress of 1,570 lbs., making a total of 12,570. The downward deflection would never exceed 3½ ft., with the limited length of train, which corresponds to a chord strain of 5,569 lbs., or a total of 11,069, so that a continuous truss could be used without exceeding the assumed limits of stress.

It should be noted that the only condition which would produce these stresses would be the passage of six maximum trains side by side. A single freight train in the most unfavorable position would produce a stress of not over 3,500 lbs. in the chords of the stiffening truss, and a single passenger train a stress of not over 1,800 lbs. In providing for a lighter structure, adapted to trains 1,000 ft. long, it should be thought best to make no reduction in the weight of the stiffening truss or the floor system, but the continuous form of truss might be selected.

If the stiffening truss did its complete duty in the distribution of weight, the greatest strain which a train 1,000 ft. long, weighing 3,000 lbs. per ft. could throw upon the cables would correspond to a uniform load of 937 lbs. If the stiffening truss did no duty whatever, but the weight was distributed strictly according to the laws of leverage, the greatest strain which such 1,000-ft. train could throw upon the cables would correspond to a uniform load of 1,582 lbs. per lin. ft. Under these circumstances it seems safe, while not reducing the stiffening truss, to provide for a moving load on the cables of only 1,500 lbs. per ft. of track. For this approximate calculation the weights per lineal foot may then be taken as follows:

	Pounds.
Suspended superstructure and tracks	34,000
Moving load	9,000
Cables and suspenders	14,000
Total	57,000

This is 28½ tons per lin. ft. instead of 34 tons, the reduction in the total carrying capacity being about 16%. It should be observed that the live load is only 15.8% of the whole, so that the additional stress put on the cables by the simultaneous passage of six maximum trains would without allowance for the work of the stiffening truss, be only 16,000 lbs. per sq. in. The stress imposed by a 1,000-ft. passenger train under the most unfavorable conditions would not be over 1,200 lbs.

For the purpose of presenting comparison, the suspended superstructure remains unchanged; all other

parts may be taken at 16% less than in the previous estimate. The weights and cost of such a bridge may then be estimated as follows:

	Pounds.
Suspended superstructure	101,000,000
Towers	64,000,000
Chains and anchor plates	25,000,000
Structural steel	190,000,000
4½ cts.	$8,550,000
Wire work	5,659,000
Total superstructure	$14,209,000
Substructure	14,684,000
	$28,873,000
And for viaduct	1,850,000
	$30,743,000

This is $4,625,000 less than the previous estimate and $4,029,000, or about 15% more than the cost of the cantilever with the 2,000-ft. clean span.

This estimate has been made for the purpose of comparing on the same basis that of a factor of safety of three on ultimate strength of metal, the 2,000-ft. cantilever and the suspension bridge when carrying train loads 1,000 ft. long.

If it be thought that the stress of 60,000 lbs. per sq. in. on the wires of the cables is too high, it may be noted that the difference in the cost of wire work in the two suspension bridge estimates is $1,017,624, and if the higher cost is restored it will be equivalent to reducing the stress in wire to about 50,000 lbs. per sq. in. With this change the cost of the lighter structure becomes $31,671,000, this being $5,038,000, or about 19% more than that of the 2,000-ft. cantilever.

If only one train is allowed on one track at a time maximum stresses will occur in the different members no oftener than the same loads would produce maximum stresses in the 2,000-ft. cantilever. Moreover, the load of 1,500 lbs. per ft. adopted for the cables is the full weight of a passenger train, and would not be exceeded if the entire span were covered with the heaviest class of passenger equipment.

Upper Location.—If a location near 69th St. were adopted, the conditions would be a little more unfavorable for the foundations of the towers, but very much more favorable for the anchorages, as rock is found above water on both sides.

The cost of the two anchorage foundations is $3,450,000 in the first estimate and $2,900,000 in the second estimate; these foundations would be saved at the upper location. These figures are enough to show that there are points within the limits prescribed by the act where the difference in cost between the 2,000-ft. cantilever and the single-span suspension bridge might be much less than has been estimated.

Conclusion.—The only subject referred to your Board is to "recommend what length of span not less than 2,000 ft. would be safe and practicable for a railroad bridge to be constructed over the Hudson River between 59th and 69th Sts."

A single span from pier head to pier head, built on either the cantilever or suspension principle, would be safe.

The estimated cost of the 3,100-ft. clear span cantilever being about twice that of the shorter span, your Board consider themselves justified in pronouncing it impracticable on financial grounds.

As the cost of the single span suspension bridge is almost one-third greater than that of the 2,000-ft. cantilever, your Board are unable to say that such greater cost is enough to render the suspension bridge impracticable.

The Board have reached this conclusion after careful study, and they have thought it best to give the full course of reasoning which they have followed. They feel that the contingency attending the construction of the deep-river foundation of the cantilever bridge, even waiving the absolute necessity of carrying this foundation to rock, is enough to balance a part of the greater cost of the suspension bridge.

The Board pronounces the suspension bridge practicable, but it does not in this conclusion give an opinion on the financial practicability and merit of either plan.

Before closing your Board desire to state particularly that the estimates have been made for comparative purposes, and are not to be taken as a measure of absolute cost.

They are believed to be thoroughly fair for comparisons; the prices assumed may be much higher than absolute cost. The plans on which the estimates are made, a sketch of which accompanies this report, would undoubtedly be modified if a bridge were built.

Respectfully submitted,

G. Bouscaren,
W. H. Burr,
Theodore Cooper,
George S. Morison,
C. W. Raymond.

THE BATES HYDRAULIC DREDGE ON THE CHICAGO DRAINAGE CANAL.

(With Inset.)

We show on our inset sheet this week a plan, elevation and perspective view of a hydraulic dredge containing some novel features of construction, which is in use on Section B of the Chicago Drainage Canal and is said to be giving excellent satisfaction. The material is a soft black loam, varying from 2 ft. to 20 ft. in depth, and is deposited outside of the levees which form the sides of the canal. The canal on this section is 202 ft. wide at the bottom, with side slopes of 2 to 1. The dredging barge is a substantially-built flat-bottom vessel, 105 ft. long, 33 ft. wide and 6 ft. 2 ins. in depth. Steam is furnished by a battery of four horizontal boilers, each 60 ins. in diameter and 16 ft. in length.

The feature of principal interest in connection with the dredge is the cutter, which, as seen by the drawings, is a hollow cylinder 5 ft. in diameter and 4 ft. in length, armed with steel knives. These are so inclined as to throw the material inward toward the opening of the suction pipe as the cutter advances. The suction pipe is 20 ins. in diameter and both it and the shaft which operates the cutter are carried by the "ladder," which takes the place of the dipper boom in an ordinary dredge. The total length of the ladder is 39 ft. At the top of the ladder a vertical telescope joint connects the steel suction pipe to the cast iron pipe on the barge. The cutter is operated by a pair of horizontal engines, mounted on the bow of the barge, as shown in the plan view.

The office of the cutter is merely to attack and loosen the material in its path. The work of lifting and transporting this material is done by water, set in motion by a 6-ft. centrifugal pump, driven by a Westinghouse engine of 250 HP., coupled directly to the pump shaft. The discharge pipe from this big pump is cast iron, 18 ins. in diameter, to the stern of the barge; here it connects to an 18-in. riveted steel pipe, made in lengths of about 33 ft. each. This is floated on the surface of the water and extends to the shore, and thence over the level to the place of delivery of the material. The joints between the lengths are made of rubber hose fastened by wrought iron clamps.

The general plan of work is as follows: The stout spud shown at the rear of the barge is forced into the bottom and on it as a pivot the barge is swung, the cutter traversing the arc of a circle 180 ft. in diameter. As the cutter rotates, of course the material is undercut one way and over cut back. The swinging is done by two cables, one anchored to each bank and both connected to a double reversing hoisting engine which pays out one cable as the other is wound in. It may be noted that the same engine has a drum for hoisting and lowering the cutter, and both motions may be made at the same time. In the plan this hoisting engine is shown located on the main deck just forward of the pump, but, as constructed, it is placed on a platform directly above the engines operating the cutter. The barge is moved ahead by means of the device shown at the rear, which is actuated by a hydraulic cylinder. The vertical spud is also raised and lowered by hydraulic power.

The discharge from the dredge contains from 5% to 30% of solid matter, depending, of course, upon the character of the material in which the cutter is working, and the average is about 15%. In some places where the mud is particularly soft it is stated that the discharge is practically a paste. The following statement of the work of one of the dredges during 13 working days is given us by the American Hydraulic Dredging Co.:

During this period there were 306½ working hours, divided into 230½ engine hours, and 76 hours during which no work was done. Of the 76 hours, 6 hours were occupied in moving the dredge to a new position; 16 hours putting in a new gear and new cutter; 14¼ hours in sundry incidental repairs, and 39¾ hours were occupied in clearing the cutter of bulrushes and long grass, and the pump of rocks, as the material being dredged during this period had over it a luxuriant growth of long grass and bulrushes and contained a considerable number of small boulders. The number of cubic yards excavated in 230½ hours was 102,900, or an average of 446 cu. yds. per working hour.

It is also stated that on special runs the machine has excavated 7,000 cu. yds. in 12 hours, or about 585 cu. yds. per hour. The dredge is working continuously, day and night, making no stops except for repairs and renewals.

The dredge was designed by Mr. Lindon W. Bates, President of the American Hydraulic Dredging Co., and we understand that some of its details are the subject of patents. We are indebted to the company for the information and drawings from which our article and illustrations have been prepared.

The dirt is deposited on the belt through a granulator, which is mounted upon a car running transversely across the bed of the canal and is fed into the granulator by a steam shovel.

The steam shovel excavates from the face of the cut, running from the south to the north over a 30-ft. radius curve and a moveable track. When the shovel has proceeded half way toward the north berm of the canal, the curved track is moved into position for the new cut, and the straight track upon which the shovel travels northward, is shifted to connect with the curve in its new position.

The car carrying the granulator straddles the lower section of the belt and follows the northward course of the steam shovel, the track being shifted westward while the car is at the north end of the cut, brings the same into position for the new cut when brought again to the south end, and before proceeding upon its northward trip the other end of the track is moved to the west.

This granulator is built in all practical respects like those commonly used in brickyards, except that it is very much heavier and stronger. On the car with the granulator is mounted a 100-HP. high-speed engine, with the necessary boiler, the engine and granulator being coupled with a friction clutch.

This granulator reduces the material deposited in it to reasonable proportions, which fall upon the belt through an aperture in the bottom of the car, and, while the same has been in operation but a few days, the time has been sufficient to state that it will readily feed 125 cu. yds. of clay per hour onto the belt, and the belt has demonstrated its capacity to transport this material on to the spoil bank in its designated location north of the north berm of the canal.

TWO NEW TIEPLATES.

The success which has attended the use of metal tieplates in effecting economy in maintenance of track has naturally led to the bringing forward of a number of different patterns, most of them modifications of plates already in use. Fig. 1 shows two tieplates designed by Mr. Benjamin Wolhaupter, of

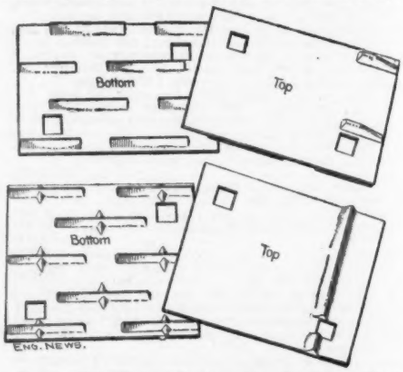


Fig. 1. Tie Plates, Designed by Benjamin Wollhaupter.

Chicago. They have four rows of discontinuous ribs, parallel with the fibers of the wood, and have also ribs on top to take the lateral thrust of the rail. One of these plates has short transverse spurs, forming ribs of spur shape, but the effect of so many points seems very liable to injure the wood by cutting and bruising. Fig. 2 shows the Columbian tieplate, invented by Mr. D. Servis, having two ribs on top, which seems an unnecessary arrangement, and two ribs on the bottom. The latter ribs are placed transversely to the fibers, but are so arranged as not to cut the same fibers, and so cut off a section of the tie. This latter plate is being sold by Servis & Bartlett, of Toledo, Ohio.

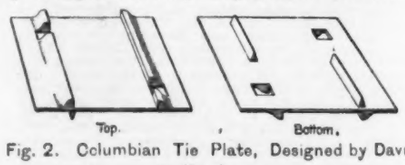
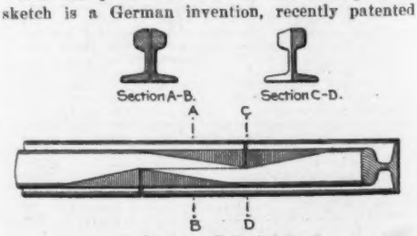


Fig. 2. Columbian Tie Plate, Designed by David Servis.

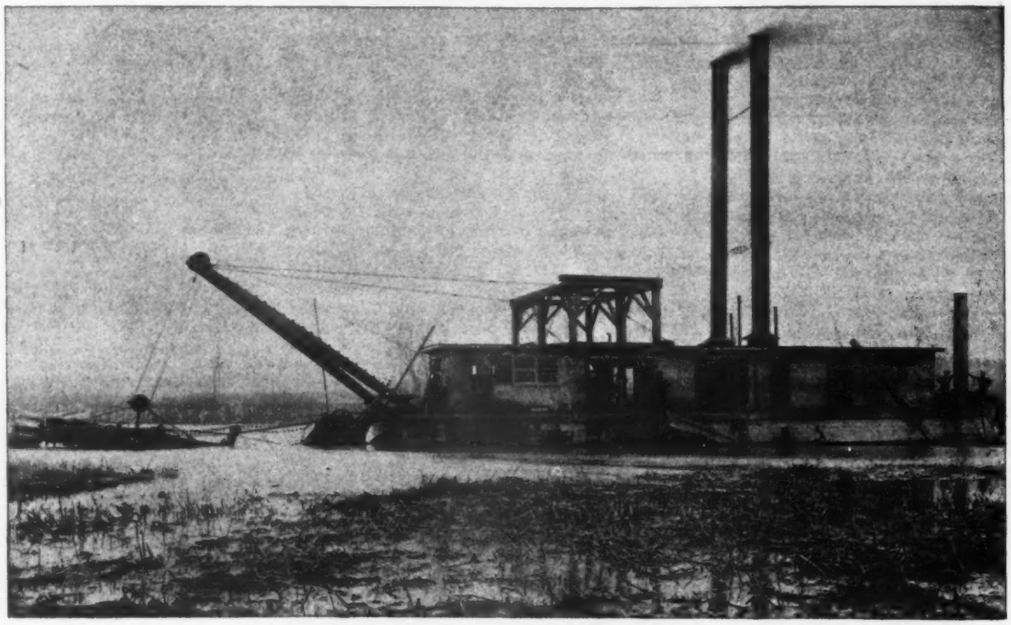
A NEW RAIL JOINT.

The rail joint illustrated in the accompanying sketch is a German invention, recently patented

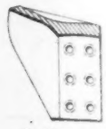


A German Rail Joint.

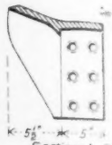
in the United States. As seen from the cut, the idea of the inventor is a variation from the old



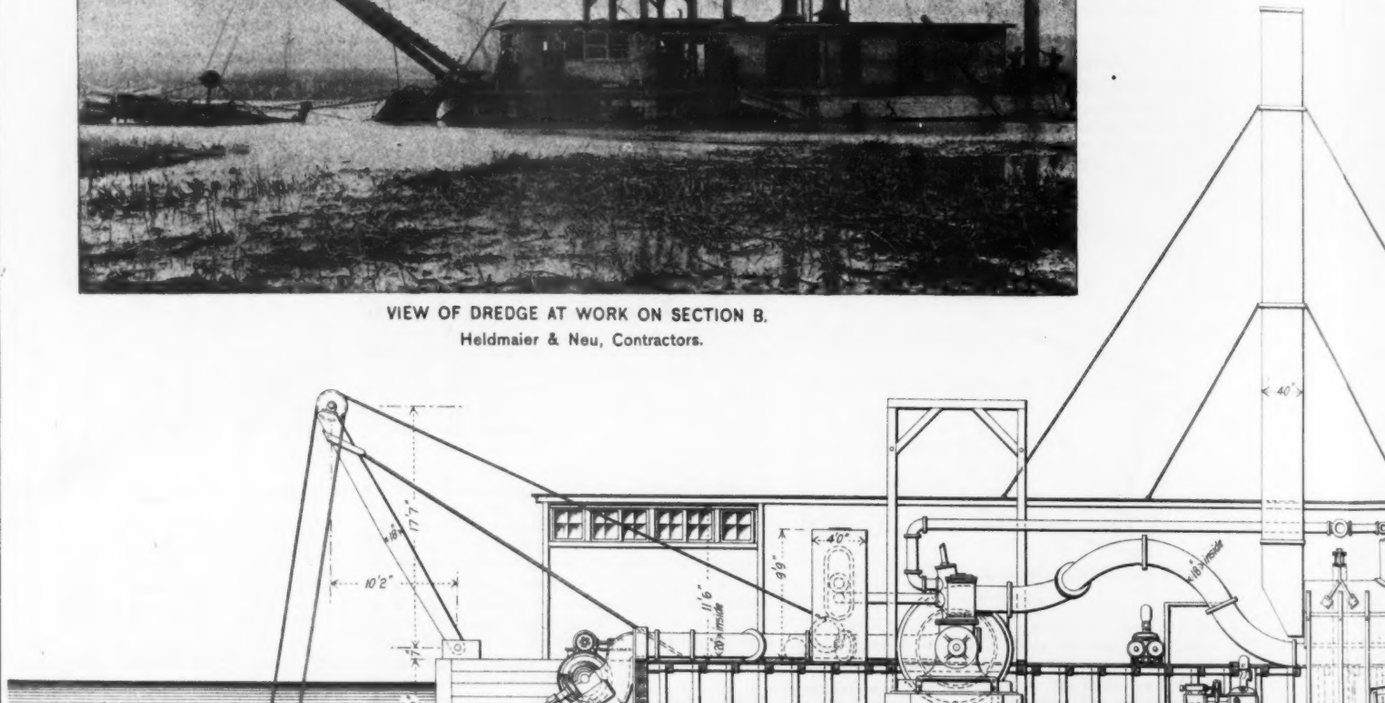
VIEW OF DREDGE AT WORK ON SECTION B.
Heidmaier & Neu, Contractors.



Section C-D.



Section A-B.



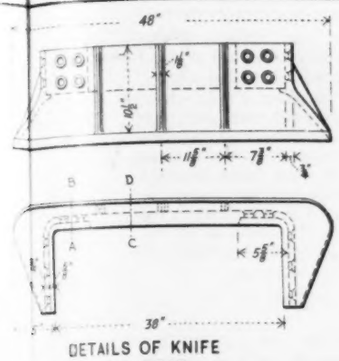
LONGITUDINAL SECTION OF DREDGE.

PLAN OF DREDGE.

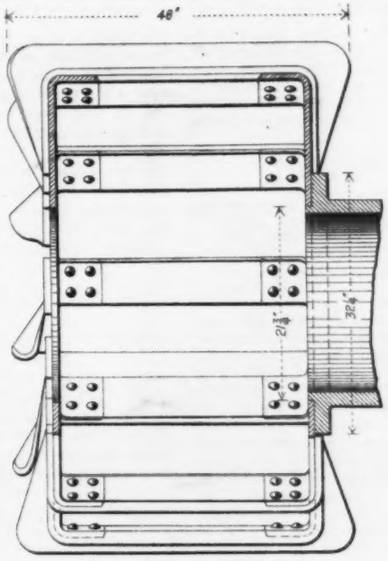
ENG. NEWS.

HYDRAULIC DREDGE ON THE C

Lindon W. Bates, Designing Engineer. The A

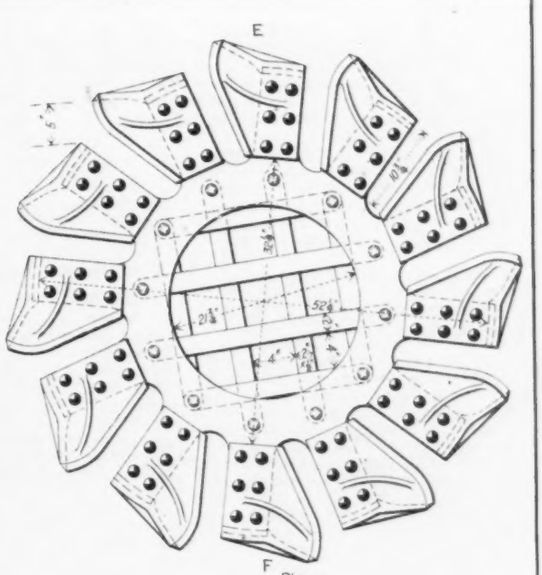


DETAILS OF KNIFE OF CUTTER.

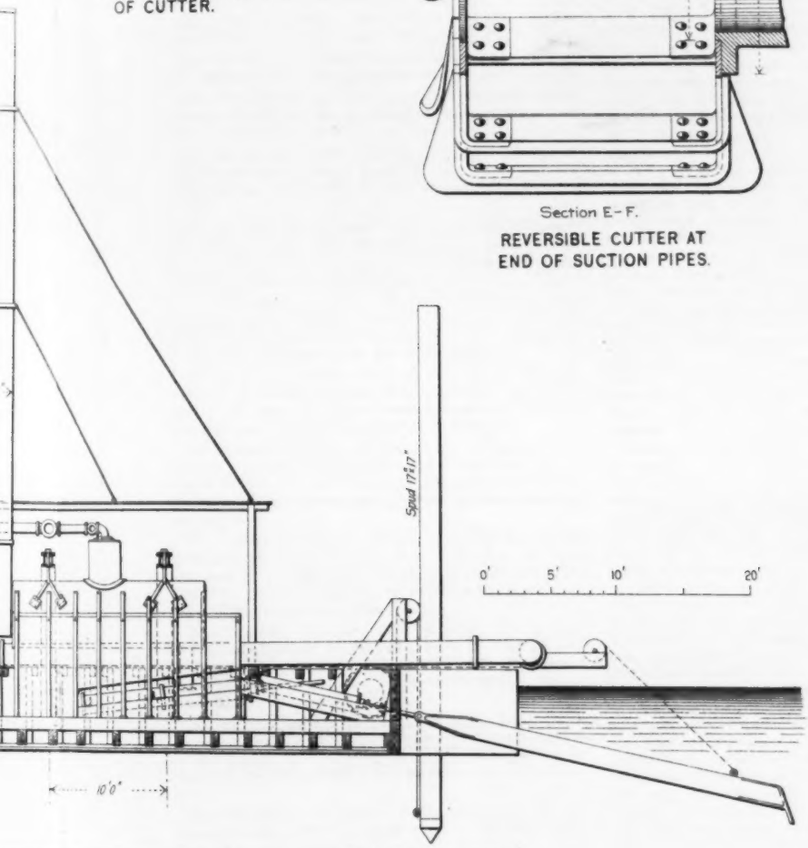


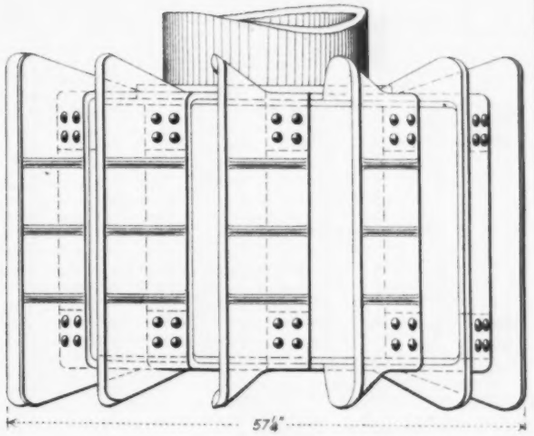
Section E-F.

REVERSIBLE CUTTER AT END OF SUCTION PIPES.

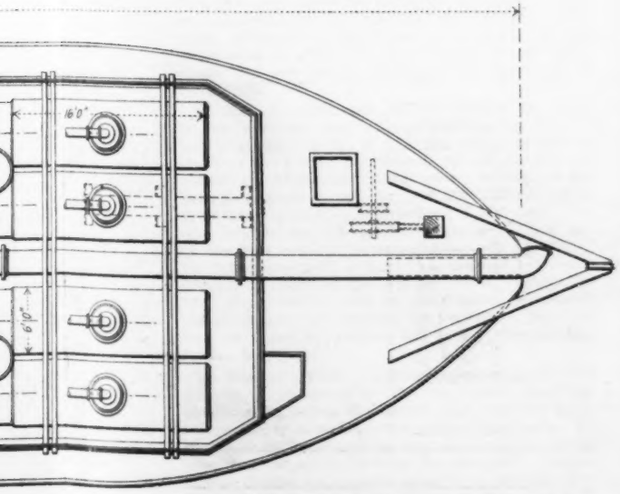


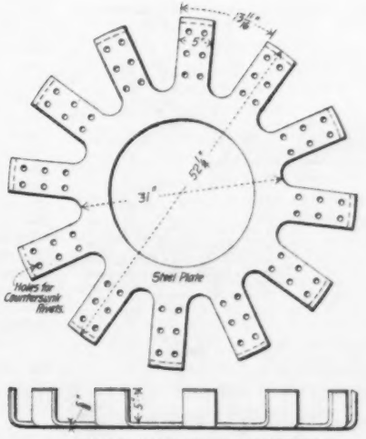
Plan.





Elevation.



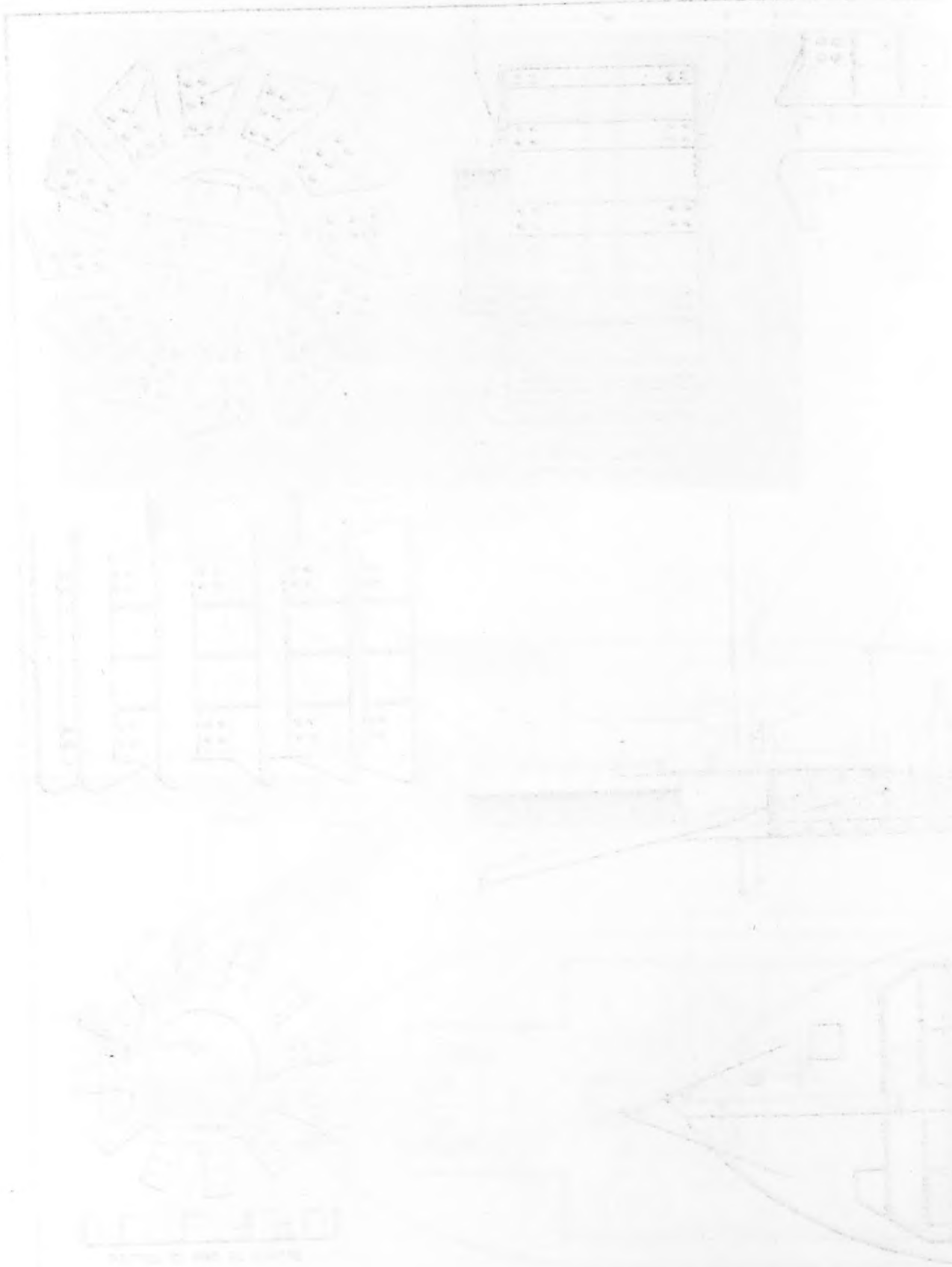


DETAILS OF DISK OF CUTTER.

THE CHICAGO DRAINAGE CANAL.

The American Hydraulic Dredging Co., Builders.

CHAS. HART & SONS, LITH., 90 WEEKY ST., N. Y.



idea of a miter joint, the novel feature being the bevel of the cut half of the rail so that the wheel will be carried on the solid half as it passes the joint, and will not strike the cut half until it is past the joint, notwithstanding the deflection of the solid half under its load. Any suitable type of fastening may be used with the joint. Apparently the inventor would have to devise a machine to cut rail ends to the form illustrated before he could hope for extended use of his joint. We are indebted to Mr. B. M. Krohn, C. E., of Phoenixville, Pa., for the drawing from which our illustration is made.

PERSONALS.

Mr. William May, railway contractor, of Paducah, Ky., was shot near Simpson, Ill., Aug. 28.

Mr. John V. Smith, a well-known architect, of Detroit, Mich., died at Saginaw, Mich., Aug. 26.

Mr. George J. Gillespie, Superintendent of the Barber Asphalt Paving Co., at Louisville, Ky., died Aug. 27.

Mr. W. S. Moore has been appointed Engineer Maintenance of Way of the Michigan Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry.

Mr. Albert H. Porter and Mr. Wallace C. Johnson, civil engineers, Niagara Falls, N. Y., have dissolved partnership. Mr. Porter is City Engineer of Niagara Falls.

Mr. Howard Carson, Chief Engineer of the Metropolitan Sewer Commission, of Boston, Mass., has been appointed Chief Engineer of the Elevated Railway and Subway Commission of that city.

Mr. Channing M. Bolton, M. Am. Soc. C. E., Chief Engineer of the Eastern Division of the Southern Ry. (formerly Richmond & Danville R. R.), has had his jurisdiction extended over the entire system.

Mr. Henry H. Carter, M. Am. Soc. C. E., Superintendent of Streets, Boston, Mass., has been appointed one of the three consulting engineers of the Elevated Railway and Subway Commission of that city.

Mr. John E. Searles, of Baltimore, Md., has been elected President of the Baltimore, Chesapeake & Atlantic Ry. Co., a new company organized to develop the railway and steamship systems of the Maryland peninsula.

Mr. Albert A. Carey, M. Am. Soc. M. E., of the Abendroth & Root Mfg. Co., New York city, has been seriously ill for the past few weeks with appendicitis, and was recently obliged to undergo an operation, from which he is recovering.

Miss Phillipa Fawcett, the daughter of the late Postmaster-General of England, says an English contemporary, has commenced the study of civil engineering at Westminster. Miss Fawcett has already taken high honors in mathematics.

Mr. Daniel Ulrich went last week to Santiago, Cuba, to fill the position of Superintendant of the Sabanilla & Moroto Ry. & Warehouse Co. The company has 40 miles of road in operation and 10 miles under construction.

Mr. Edward P. Thompson, M. E., of New York city, has associated with him Prof. Wm. A. Anthony, Past Pres. American Institute Electrical Engineers. They are prepared to act as consulting electricians to engineers, architects, corporations, cities, etc., for the preparation of plans and specifications for electrical plants, and also for the preparation of specifications for patents.

Mr. John C. Gault, who died at Chicago, Ill., Aug. 30, was a railway man of large experience. He was born at Hookset, N. H., in 1829, and began his railway career in the freight department. In 1864 he was appointed Superintendent of the Galena Division of the Chicago & Northwestern Ry., and from 1870 to April, 1872, was General Superintendent of the road. He then went to the Chicago, Milwaukee & St. Paul Ry. as Assistant General Superintendent, and established the Chicago terminal of that road. In 1879 he became General Manager of the Wabash R. R., retiring in 1883. From 1885 to 1890 he was General Manager of the associated roads forming the Cincinnati, New Orleans & Texas Ry. system, but retired from railway service in 1890.

Mr. Charles Liddell, a leading English engineer, died Aug. 10, at the age of 81. He was a pupil of and assistant under George Stephenson, and continued in active service until within a few weeks of his death. He was remarkably expert in railway location, having what may be called an "eye for country." Besides several English railways he constructed the Danube & Black Sea Railway and the Novara & Lake Orta Railway (in Italy). As a partner with Mr. Gordon and Mr. R. S. Newall, in the firm of R. S. Newall & Co., wire-rope makers, Mr. Liddell took an active part in laying submarine telegraph cables. During the Crimean War he laid a cable between Varna and Balaclava. He also laid several cables in the Levant. His latest work was as Chief Engineer for the London extension of the Manchester, Sheffield & Lincolnshire Ry., which will give London a new trunk line to the north, and which was laid out entirely by him.

NEW PUBLICATIONS.

ROOFS AND BRIDGES—A Text-Book on. Part III. Bridge Design. By Mansfield Merriman, Professor Civil Engineering in Lehigh University, and Henry S. Jacoby, Assoc. Professor of Civil Engineering in Cornell University. New York: John Wiley & Sons. 8vo; cloth; 425 pp.; many diagrams and 18 folding plates; $5.00.

This new volume of the work of Professors Merriman and Jacoby (following Part I., on stresses in simple trusses, and Part II., treating of graphic statics) commences with an unusual feature for a text-book, a brief history of bridge design. The authors tell of its development and give references to the chief literature on this subject. Timber construction in the United States, according to this chapter, may be roughly divided up into periods and types as follows: The combined arch and truss of Theodore Burr and Timothy Palmer, of 1804-5; the Louis Wernwag, 340-ft. arch of 1812; the pinned-lattice truss of Town in 1820; the greatly improved counter-braced truss of S. H. Long, of 1830; the Howe combination iron and wood truss, of 1840, and the Pratt truss of 1844. Iron bridges appeared in 1840, usually having cast iron curved upper chords with a straight lower chord of wrought iron. But Squire Whipple, in 1847, first rationally discussed the determination of stresses and the proper proportions of cross-sections, in "A Work on Bridge Building," published in that year at Utica, N. Y. Whipple is justly regarded as the father of American rational bridge design, and from the impetus given by him, the later construction in iron and steel had its origin. The first bridge, pin-connected throughout, was built in 1860 by John W. Murphy on the Lehigh Valley R. R., at Phillipsburg, N. J.; though wide forged eyebars used in connection with pins were employed in 1861, by J. H. Linville, on the Pennsylvania R. R.

Returning to the subject matter proper of this work, we find the second chapter devoted to the principles of economic design; covering number of piers and spans, choice of type of bridge, theoretic comparison of trusses, economic depth and practical considerations. Next come tables and standards; an exceedingly useful chapter of hints as to loads, rivets, channels, eyebars, bridge floors, etc. Each of the following chapters takes up the complete design of some standard type of structure; from the design of a roof-truss, or a plate-girder bridge to the more complicated forms of trusses. Each case is treated in a thoroughly rational and practical manner; the design is based upon standard specifications and actual structures from data supplied by well known engineers, and every requirement is carried out and exhaustively and plainly discussed. The mathematics sparingly used are of the simplest form, and throughout frequent references are made to authorities and to publications further discussing the case presented.

Chapter IX. treats of bridge-letting and office work; and we here find bits of practical advice too often omitted in works of this character. The first, and an important one, is that while any one can buy a bridge, only an engineer of experience should buy one, or can prepare the specifications for a stable and economical structure. Young engineers are reminded that the preparation of an original specification requires a large amount of practical experience and observation; and they are advised to base their earlier efforts in this line upon well known existing specifications, modified with due care and intelligence to suit special needs. The chapters following discuss bridge shops and buildings and shop practice, with illustrations and descriptions of some of the principal tools used. The closing chapters relate to elevated railway construction and to the designing and building of highway bridges for an electrical railway. Of the whole work it may be said that it is one of the most satisfactory and useful publications upon this subject that has yet appeared; and is in itself convincing proof that the art of book-making for engineering students has developed along with the art of bridge-building. The treatment is rational and thoroughly practical; and the result is a work extremely useful to the young engineer and to the student.

ROADS AND PAVEMENTS—A Text-Book on. By Fred P. Spalding, M. Am. Soc. C. E., Asst. Professor of Civil Engineering in Cornell University. New York: John Wiley & Sons. 8vo; 213 pp.; fully illustrated; $2.00.

This work briefly discusses, from an engineering standpoint, the principles involved in highway construction, and gives considerable space to the location and building of country roads. The general considerations to be observed are given in the first chapter, and include the resistance to traction, tractive power of horses on various surfaces and the healthfulness, safety and durability of the type of road proposed. Then follow chapters devoted to the subject of drainage, the location and improvement of country roads, broken stone roads, pavement foundations and brick, asphalt, stone-block and wood street pavements. The last chapter treats of city streets, their arrangement, gradients, intersections and appurtenances. Professor Spalding does not attempt to exhaustively handle road and pavement construction in these pages; but he does provide a sound basis for a systematic study of the subject. While it is a work primarily intended for students, it is extremely useful to any one interested in the improvement of streets and roads, in plainly laying down the fundamental principles governing this class of public works.

NEW STADIA CHARTS, for rapidly finding distance and height from stadia reading and vertical angle in plane-table and transit surveys with stadia wires, telemeter-rod and vertical arc. Designed by Edward P. Adams. Boston: Published by the Author. Pamphlet; 11 pp.; with two charts.

As a substitute for tables and to increase the rapidity of obtaining distance and height in plane-table surveys, Mr. Adams has devised two stadia charts of a size that with one folding will go into a field note-book. One chart gives angle of incline from 0 to 5°, and the other from 5° to 15°; the first chart being graduated to every 5', and the other to every 10'. Distances extend to 500 ft. and both charts are graduated to every 10 ft. in stadia distance, to single feet in height and to single feet in correction of distances. The text fully explains their method of use. While the charts are marked "feet," they can be used for meters if the "optical corrections" are made according to metric units.

UNITED STATES TARIFF, Handbook of the: Containing the Customs Tariff Act of 1894. With complete schedules of articles with proper rates of duty; also a full explanation of customs requirements, and of the laws and regulations regarding drawback, with a list of articles on which drawback rates have been established. New York: F. B. Vandegrift & Co., 27 William St. 16mo; paper; 547 pp.; $1.50.

The new tariff law is an usually complicated document, and the present handbook explaining its real meaning should be a welcome publication to the business world. Over 12,000 articles are included in this digest, which is claimed by the publishers to be the most complete ever issued on this subject. It is interspersed with copious decisions and annotations; contains a list of foreign coins with the values established by the Director of the Mint, and includes a foreign express tariff, the administration law and other laws on the enforcement of the customs requirements. The publishers inform us that it will be for sale on all stands of the American News Co. throughout the United States.

TRADE CATALOGUES.

ROAD AND GRADING MACHINERY. F. C. Austin Mfg. Co., Chicago, Ill. 8vo; oblong; pp. 24; illustrated.

This pamphlet contains descriptions of the New Era grader and its methods of operation (Eng. News, Nov. 30, 1893) for road, railway and ditch work, together with diagrams of cross-sections of excavation and embankment. The Austin dump wagon (Eng. News, Sept. 1, 1892) and road machines are also illustrated.

COMING TECHNICAL MEETINGS.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Sept. 7. Secy., O. Von Geldern, 719 Market St., San Francisco.

WISCONSIN POLYTECHNIC SOCIETY.
Sept. 10. Secy., Geo. G. Mason, 144 8th St., Milwaukee.

AMERICAN SOCIETY OF IRRIGATION ENGINEERS.
Sept. 10. Annual Meeting at Denver. Secy., J. S. Titcomb, Denver.

NORTHWEST RAILWAY CLUB.
Sept. 11. Secy., W. D. Crosman, Ryan Hotel, St. Paul.

NORTHWESTERN SOCIETY OF ENGINEERS.
Sept 11. Secy., D. W. McMorris, Burke Blk., Seattle, Wash.

ROADMASTERS' ASSOCIATION OF AMERICA.
Sept. 11, 12, 13. New York. Secy., W. W. Sharpe, Waycross, Ga.

DENVER SOCIETY OF CIVIL ENGINEERS.
Sept. 11. Secy., F. Ed. King, 36 Jacobson Block.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
Sept. 11. Secretary, F. C. Osborn, 721 Hickox Building.

ENGINEERS AND ARCHITECTS' CLUB OF LOUISVILLE.
Sept. 13. Secy., G. W. Shaw, Norton Building.

COMMISSIONERS OF PUBLIC WORKS.
Sept. 19. Buffalo, N. Y. M. J. Murphy, St. Louis, Mo.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 25 to 28. Montreal, P. Q. Secretary, Dr. Irving A. Watson, Concord, N. H.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 19 Secy., Francis Collingwood, 127 E. 23d St., N. Y.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 2 to 6. Bridgeport, Conn. Secy., R. W. Raymond, New York.

WESTERN SOCIETY OF ENGINEERS.
Oct. 3. Secy., Thos. Appleton, Lakeside Bldg., Chicago.

ASSOC. SUPERINTENDENTS OF BRIDGES & BUILDING.
Oct. 16. Kansas City, Mo. Secy., S. F. Patterson, Concord, N. H.

AMERICAN SOCIETY OF RAILWAY SUPERINTENDENTS.
Oct. 20. New York. Secy., G. A. Hammond, Boston.

SOCIETY NAVAL ARCHITECTS AND MARINE ENGINEERS
Nov. 15 and 16. Annual Convention in New York city
Secy., W. L. Capps, U. S. N., Washington, D. C.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 3 to 7. Secy., F. R. Hutton, 12 W. 31st St., New York

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.
Entered at the Post Office, New York, as Second Class Matter.

VOL. XXXII. THURSDAY, SEPT. 6, 1894.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS.
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER.....ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER.
F. P. BURT.....ASSISTANT MANAGER

CHICAGO OFFICE: 1,636 The Monadnock.
CHAS. S. HILL.....RESIDENT EDITOR.
F. A. PECKHAM.....ADVERTISING MANAGER.

EUROPEAN AGENCIES:
KEGAN PAUL, TRENCH, TRUEBNER & Co. (Limited), Paternoster House, Charing Cross Road, London, Eng.
SAMPSON LOW, MARSTON & Co. (Limited), St. Dunstan's House Fetter Lane, London, Eng.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00; single copies, 15 cents. To all other countries in the Postal Union, add $2.08 per annum (4 cents per number) to above prices for postage. No club rates allowed. Mailing addresses may be changed at will by sending both old and new address. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The date when the subscription expires is on the address label on each paper; the change of this to a subsequent date is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

We reprint in another column a brief paper from the Proceedings of the Institution of Civil Engineers describing an Italian rack railway, which employs a form of rack-rail similar to the well-known Abt rail, but cheaper and simpler in construction. In connection with this article we desire to call attention to the profile of the road which accompanies it, and on which is placed a "curve diagram," which will, we believe, be new to most of our readers. It shows at a glance the comparative length of curvature and tangent on the line and seems to be a desirable addition to a railway profile.

The commission of engineering experts appointed by the President to investigate and recommend a safe and practicable span, of not less than 2,000 ft., for the proposed railway bridge across the Hudson River at New York has made its report. It condemns the cantilever type as safe and possible but impracticable for the longer span, and practically recommends a suspension span of 3,100 ft. With only 2,000-ft. spans and a center-river pier, the cantilever bridge would cost $26,723,000; and in this estimate $9,710,000 is charged to the center pier alone, which requires a foundation 260 ft. deep from surface of water to the rock. For a 3,100-ft. clear span cantilever the estimated cost is $51,128,000, which is prohibitory. The commission, however, is satisfied that a six-track 3,100-ft. single span suspension bridge could be erected for $35,367,671; and a somewhat lighter structure of the same span, that would meet all possible demands with absolute safety, could be built for $30,743,000. The experts "feel that the contingency attending the construction of the deep-river foundation of the cantilever bridge is enough to balance a part of the greater cost of the suspension bridge."

Aside from all question of comparative cost and risks of erection, the people of New York have good reason to feel grateful to this engineering commission for approving what is undoubtedly the handsomer type of bridge of the two plans submitted, and one better fitted to do honor to the conspicuous site and its position in the center of the millions of the metropolis of the United States. A cantilever bridge is an inherently ugly and ungraceful type of structure, with its awkward angles and straight lines at different elevations and inclinations, while of all types of bridges the arch or the suspended cable is the most pleasing to the eye. If it were a question of crossing some stream or valley in the mountains or woods, where the chief and practically only purpose is to provide a safe structure with the least outlay of capital possible, the designer would be justified in adopting the most economic arrangement of members, regardless of appearances. But for a bridge crossing the busy harbor of New York and spanning one of the noblest rivers on this continent something else is required. This bridge, if built at all, will far exceed in length of clear span and depth of foundations anything yet attempted by the world's engineers, and its lines and general effect should be worthy of its prominence among engineering structures.

In commenting upon the estimates of cost given by the experts we note that some of the New York papers do not appreciate the true meaning of the engineering expression of "contingencies" in connection with the construction of the deep-river foundations of the 2,000-ft. span cantilever bridge. The New York "Times" seems to think that because the depth of foundation and the general dimensions of the proposed pier are known quantities the cost of construction must also be a fixed sum. Our contemporary evidently does not appreciate the risks involved in founding a suitable pier upon rock 260 ft. below the river surface; a foundation of enormous proportions, sunk 100 ft. deeper than any yet attempted by engineers. It is in these large and deep foundations, through material of a practically unknown nature, subjected to tidal influence or river current, that the "contingencies" of bridge building are located in great part. If we remember rightly, the increase over the estimated cost of sinking the piers for the St. Louis bridge amounted to about 80% of their final cost, owing to the development of an unexpected bottom scour, change in pier material found necessary, sunken steamboats encountered, etc. The accident to the pier of the Forth bridge, while being sunk, enormously increased its cost, and two of the great caissons of the Poughkeepsie bridge floated off down the river, entailing additional expense in bringing them back that swelled the "contingency" fund in that case. The risks from storms, and from any number of contingencies that the ablest engineers cannot foresee are in almost exact proportion to the depth of water, dimensions of the foundation and exposed site of the structure, and these are all abnormally great in the case discussed and absolutely without precedent among finished engineering works. In the case of a 3,100-ft. clear span, both the cantilever and the suspension bridges would have the marked advantage of a greatly reduced depth of pier foundation; 125 ft. below mean high tide, instead of 260 ft., with a proportional decrease in risk. But in this case the suspension bridge, according to the report of the engineers, is quite as "safe and practicable" and has all the advantage in matter of cost; the two estimates ranking as $51,128,000 to $35,367,671; and a lighter but fully sufficient suspension bridge could be built, the board says, for $30,743,000. In fact, the North River Bridge Co. has published completed plans for a suspended span of 2,950 ft., located at Hoboken, for which the estimated cost is only $21,000,000. In effect, this board of expert engineers, after a careful study of the problem of bridging the Hudson River at this point, has arrived at the same conclusion as did Mr. Lindenthal, the engineer of the suspension bridge first proposed some years ago. This conclusion is, that taking into full consideration the risks attending abnormally deep river foundations and the requirements of an unobstructed harbor, the most feasible plan of bridging this deep stream is by means of a single span suspension bridge, the practicability of which for long-span railway bridges was long maintained and defended by the original proposer of the suspension type, and is now approved by the official report of the board of experts. As to comparative cost, there is only $4,020,000 difference between the board's estimate for a 2,000-ft. cantilever and a 3,100-ft. clear span suspension bridge; and, with a 260-ft. foundation to deal with in the first case, the existing difference of 15% might readily be wiped out before the structure was completed.

In this connection it may be said that the bridge designers of Europe pay much more attention to the general appearance of their structures than do our own engineers, especially when their bridges are located in or near centers of populations. Bridge designing and bridge decoration are two distinct branches of engineering, too seldom combined in the work of American engineers, if we may judge them by the structures about us. Though it must be here said that the primal fault generally lies with the corporation providing the means, and which, for the sake of cheapness, prefers to sacrifice all esthetical considerations to the mere commercial demands of the project. As showing what Continental engineers can do, even with so unpromising a basis as the cantilever type of bridge, it is interesting to examine one of the prize designs submitted for the proposed Budapest bridge. This bridge, of 1,013 ft. span, is actually a cantilever bridge with a suspended center span, anchorages and level roadway, combining all the claimed advantages of this type of structure. Yet the parts are so arranged that the bridge appears to be a somewhat novel but comparatively very handsome arched structure, with the roadway suspended a little above the springing line of the supposed arch. The objection to this bridge, however, is that it tells a structural lie, in appearing to be one thing while it is really something else. With comparatively short spans, or under favorable conditions of situation, the cantilever, with some extra outlay, can be made to very nearly assume the arched or inverted arch form, and yet remain true to itself. But when it comes to long spans, with a shipway to be provided for beneath, it is practically impossible to so dispose of its members that the final effect would be pleasing. No better proof of this is needed than the published plans of the proposed Hudson River cantilever bridge, prepared by one of the best known and most experienced and capable engineering firms in the country.

The paper on cross-sections of railway roadbeds which we publish on another page is an advance chapter of a work on railway track which is now in an advanced stage of preparation, and is soon to be issued by the Engineering News Publishing Co. We shall give further space to some of the important chapters of the book in later issues. The technical literature on the subject of track and maintenance of way is comparatively limited, if we exclude the extensive but scattered literature of books and pamphlets devoted to various individual details. The first practical and comprehensive book on this subject was "The Roadmaster's and Sectionmaster's Guide," written in 1871 by Mr. W. S. Huntington, and revised and enlarged some years later by the late Charles Latimer. This was followed in 1886 by "Track," written by Mr. W. B. Parsons, M. Am. Soc. C. E., a work which had a large sale and is now out of print. Probably the only other comprehensive work is "The Trackman's Helper," written by Mr. J. Kindelan, which is a book intended especially for the use of section foremen. Parson's "Track" is familiar to every engineer on railway work, but it was not as comprehensive a work as is now demanded, and in many respects it is now somewhat behind the times. Since its publication there have been marked advances in track work, notably in the use of heavier rails, metal tieplates, and in the introduction of signals and interlocking plant for the safer movement of trains. The improvement in track, however, has not kept pace with the growth of traffic and increase of wheel loads and train loads, for the relation of the track and its maintenance to the safety and speed of trains, the train loads which can be hauled, and the economy of operation, are matters very generally overlooked by the financial and executive officers of railway companies. Practical experience, however, has conclusively shown the importance of good and smooth track in securing the maximum work by locomotive equipment, and the fact is coming to be recognized that the poorer the track the greater will be the expenses of maintenance, owing to the inability of the track to sustain the weight and shocks to which it is subjected. In fact, heavy expenditures for more powerful locomotives may in some cases be avoided by lighter expenditures to bring the track into such condition as to enable the present equipment to handle the traffic.

The liability of a city for fire losses in case it fails to maintain its water-works in an efficient condition has recently been held by the New York Supreme Court. A loss of $4,450 was paid by the

Springfield Fire & Marine Insurance Co. on a dwelling in Keeseville, N. Y. The company sued the village for $4,500, claiming that the loss would not have been over $300 if the water-works, owned and operated by the village, had been in proper condition. The insurance company alleged that the pumps and pipes of the water-works and the fire appliances of the village were so out of repair that water could not be thrown upon the house. It stated that because there were water-works in the village the insurance rates on the house had been made 40% less than on property outside the corporate limits and beyond the reach of the water-works system. The village demurred to the complaint before the trial court, claiming that the allegations were not sufficient ground for action. The trial court sustained the demurrer, but the general term overruled it, giving the village leave to plead over. In overruling the demurrer Judge Herrick gave the following opinion:

> The defendant receives rents for supplying water; it has control over all the employees connected with the water-works; it can employ and discharge them at pleasure; they are its servants. The construction and maintenance of the water-works is something that was not forced upon it by the power of the state; it could act under the law authorizing it to construct and maintain water-works or refuse to act, at its pleasure; but having accepted the power and authority granted, it became responsible for the proper exercise of such powers. . . . To hold that a municipality shall in no case be held liable for damages resulting from employing incompetent men, or for knowingly or negligently permitting its water-works, mains and pipes to become and remain out of repair and unfit for service, would remove one great incentive to furnish an efficient water service. Ordinarily, where there is no responsibility there is an inefficient public service.

Whether the village availed itself of the opportunity for further pleading the case we do not know. But even if it did, and if the insurance company was unable to prove its allegations against the village, the opinion given above is no less a warning to all municipalities pretending to protect property from fire. Similar decisions have doubtless been rendered before, but fresh warnings are needing in many cities and villages throughout the country. Undoubtedly there have been in the last few years many fire losses which might have been recovered from the cities or companies operating water-works. A variety of causes prevent action to collect such damages, among which may be mentioned the American habit of tolerating inefficiency from public servants and the aversion which many have, through political or other reasons, to enter into legal controversies with municipalities or with companies performing public functions. In some localities it is said to be no easy task to engage counsel for such suits, but doubtless a good large retainer would overcome any difficulties in this line.

Where water-works are owned by municipalities it often happens that the people themselves are directly, as they generally are indirectly, responsible for poor fire protection, through failure to vote the necessary funds. In case a citizen who had voted against raising money to render the water-works of his city efficient should lose property by fire because of the inefficiency of the works, it would be an interesting question whether he could recover damages. The decision cited above was in a different case, the insurance company, of course, having no voice in local affairs.

How many cities to-day are dependent for their fire protection upon a single pump or supply main, often long in service? How many cities have fire hydrants which have not been used or tested for years, but which may at any moment be tried and found wanting? The number of towns of any size still wholly without a water supply for fire protection is now small, still there are many small villages where an outlay of a few thousand dollars this fall might save at least an equal amount before the winter is over.

CONCERNING CIVIL ENGINEERS IN THE U. S. NAVY.

Sections 62-64 of the Navy Reorganization Bill, lately before Congress, propose to abolish the present civil engineering staff of the Navy by making no new appointments and allowing that corps to die with the present officers. The framers of the bill still recognize the necessity for the services of engineers at the several yards, but they provide for this service in the future in a manner that is as absurd as it will undoubtedly be detrimental to the future engineering needs of the Navy Department. Hereafter all civil engineers, by the wording of these sections, are to be appointed by the President for a term not exceeding four years, and at a salary not exceeding $2,500 per annum. These civil engineers shall not be eligible for a position on the retired list; they hold no official commissions and their connection with the Navy ceases with their tenure of office. In short, they are civilians, hired for a short time, on small pay, absolutely under the control of line officers of the Navy and with no official position.

Coupled with the further provision in the same bill, that the Chief of the Bureau of Yards and Docks must be a line officer not below the grade of commander, it is difficult to see how a higher premium could have been offered for unskilled, inefficient and wasteful engineering work in connection with a branch of the Navy Department that has to deal with pure civil engineering of a very high order. At the present time this corps, limited in number as it is, is in responsible charge of nearly $50,000,000 worth of public work. These civil engineers have to locate our new yards and docks, design these important structures in accordance with the latest dictates of engineering science, superintend their construction, design and build new shops, sea-walls, etc., and carefully investigate and report upon all matters of a civil engineering nature that constantly come before the Chief of the Bureau of Yards and Docks. Under the existing law, and under the new law as framed, this Chief is a figure-head only, as far as any ability to decide upon engineering projects is concerned. Both he and the government depend solely for correct, economical and efficient design and construction upon the experience of the present civil engineers of the Navy, an experience gained by long special service, coupled with perfect familiarity with the business in hand. The Chief now relies upon the ability of the naval civil engineers to perform their duty properly, and simply sets his signature to their plans as a matter of form, and because he appreciates the fact that he cannot suggest any important alterations or amendments.

The new law proposes to remove this prop to the Chief of the Bureau of Yards and Docks and make him a civil engineer in spite of himself, notwithstanding his absolute unfitness for the duties imposed and his avowed contempt for all that has to do with engineering. Otherwise, who is to decide upon the fitness of the designs submitted by a newly-appointed civil engineer, working for a salary absurdly low, considering the importance of the work, and presumably utterly unfamiliar with prevailing conditions and the detail of naval dock and yard construction. The conditions of the appointment and pay and the complete subordination to a class of officers who are not engineers, but still have the power to direct engineers in all things, will certainly not attract a very able class of professional men to this service. Naval civil engineers of experience are not plentiful in the United States, for very evident reasons; and the result of any such law as that proposed will undoubtedly be to make Uncle Sam pay roundly for the training of the new engineers in charge—an education and experience that may have to be repeated every four years, owing to the selection of new engineers by a new administration.

Out upon such false "economy" and utter disregard for business principles and the best interests of our government. It is an economy born purely of class jealousy and the desire to hold power and office regardless of fitness. The present law is bad enough, as has often been pointed out in these pages, in keeping at the head of an important civil engineering bureau a class of officials who have no engineering knowledge or experience. But the new law is much worse in retaining this one very objectionable feature, and in removing absolutely the only safeguard in this anomalous position—a corps of commissioned, responsible civil engineers of tried ability and long experience, who now can, and do, act as safe advisers to their technically ignorant chief.

The framers of the new law, however, the line officers of the United States Navy, make one convicting admission in the first line of the Section 62 referred to, viz.: "There shall be in the Bureau of Yards and Docks one civil engineer." In other words, they recognize the need of a technical adviser, and propose that this "one civil engineer" shall assume all technical responsibility and do all their work for them. This one engineer would apparently have a very safe tenure of office, for without the aid of his knowledge and experience any newly appointed Chief would be utterly lost. What would happen meanwhile at the various yards as the result of ignorance and inexperience in the engineers in charge, coupled with the meddling of line officers in charge of them, would be immaterial. The Chief would always have a convenient "scapegoat" in the person of the "one civil engineer" at the bureau, and could pile all the blame upon him. The official Chief is not presumed to know anything about the works under his charge by his fellow line officers nor by the administration appointing him.

This method of doing business in what is now one of the most important bureaus in the U. S. Navy Department, a bureau controlling the expenditure of millions of public money, would be very properly condemned in the conduct of the most ordinary corporation. It would not be permitted, in fact, at all, and the sooner Congressmen, who are wrongly supposed to frame and be responsible for the new law, open their eyes to the true inwardness of Sections 62-64, the better it will be for the future credit of our naval construction and the proper and economical use of public money invested therein.

LETTERS TO THE EDITOR.

THE THEORY OF RESILIENCE.

Sir: In your issue of Aug. 2 you reproduce with comparative fullness an abstract of Mr. E. D. Estrada's paper on "Impact Tests of Iron and Steel," and the discussion thereon, supplemented by extended editorial comments. Before such experiments can be profitably discussed, it is essential that the fundamental theories underlying the discussion should be well established. The discussion elicited by Mr. Estrada's paper led the present writer to believe that the principles of resilience as developed in our text-books are not well founded, in so far as they depend upon measuring the work of static force by the product of the force by the amount of deformation produced. This error was made the subject of a paper read before the Engineers' Society of Western Pennsylvania at its meeting on April 19, 1894, and discussed at that and the subsequent meeting of May 17. Permit me to trespass on your valuable space to briefly present a few salient points on this subject.

1. When a bar is subjected to a tensile stress, by opposing forces, the bar is stretched by a certain amount. If W = the load, and E the resulting stretch, then according to the text-books the work, which we will call Q, will be Q = WE. Keeping within the elastic limit, for the same bar, E will always be proportional to W. Hence, when the load is 2W, the stretch will be 2E, and for that case Q = 4WE.

Similarly for 3W, Q = 9WE, and so on, the work increasing in proportion to the square of the load. To engineers who know that under the same conditions ten men can only do ten times the work of one man, and that ten tons of coal can only perform ten times as much work as one ton, a proposition which requires 10 units of force to produce 100 times the work of one unit, under identical conditions, should need no argument to establish the presence of error; and it would seem unnecessary to enlarge on this point.

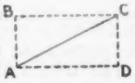
The chief question would seem to be, What is the error, and wherein does it lie? The writer conceives that it lies in the fact that the conception of work as the product of a force and a distance belongs wholly to the field of dynamics, and can have no proper application to static conditions. To quote his own remarks from the May "Proceedings of the Engineers' Society of Western Pennsylvania":

> All dynamic laws originate primarily in the study of falling bodies, and presuppose a motion which transports the body, as a whole, from one point in space to another point in space, with all the concomitant phenomena of velocity, momentum and vis viva. The motion incident to deformation is not a motion of this character. It would be difficult to conceive of momentum and vis viva in connection with this form of motion. With dynamic motion, when the active force ceases, the momentum of the body carries it forward in the same direction. But with the motion of deformation, when the force ceases to act, the particles instantly move in the reverse direction and seek to return to their original positions. The two forms of motion are entirely distinct, and have nothing in common. Deformation is molecular motion within the mass, not bodily motion of the mass, and laws deduced from the latter cannot be predicated of, nor applied to, the former.

Yet this is precisely what our text-books have done. The error lies in this initial step, and vitiates all that follows it. There can be no work, in the dynamic sense, under static conditions; that is to say, when force is resisted, and the only motion is molecular, resulting in change of form of the resisting body. If we would apply the term work to these conditions, we must abandon the special definition founded on

dynamics, and use the term in its general sense, viz.: the effect produced by the expenditure of force, which in this case is stress. If we continue the restricted meaning of the word as used in mechanics, then we must consider that there is no work, but only a transformation of force into stress. In the same way, a dynamic blow resisted is converted into stress, accompanied by deformation. If we multiply the foot-pounds of the blow by the feet of deformation, what shall we call the product?

2. But further on in the development of the subject other errors creep in. When the text-books assert that the stretch due to a sudden load is twice as great as that of the same load gradually applied, they reach that conclusion by the following process of reasoning: The work of a sudden load, A B, producing the stretch A D, is represented by the area of the rectangle A B C D; and that of the same load gradually applied by the area of the triangle A C D.



The area of the rectangle is twice as great as that of the triangle, therefore, the work of the sudden load is twice as great as that of the same load gradually applied.

The next step in the argument is, that because the work is twice as great, therefore the stretch is also twice as great. In the language of mathematics this would be, because the rectangle A B C D has twice the area of the triangle A C D; therefore the side A D is twice as great as itself. A most illogical conclusion.

When this presentation of the subject was laid before one of our leading professors of engineering, by private correspondence, he replied that I had misapprehended the text-books. It is true that the text-books do not state the subject in all the naked baldness in which it is here presented. It is safe to say, had they done so, the authors would have seen their own error before getting into print.

If the reasoning of the text-books is not correctly outlined in the foregoing paragraphs, then will some one kindly present a clear and succinct statement of the logical sequence by which the text-books reach the conclusion that the stretch is twice as great in the one case as in the other? As the writer reads the text-books, he can analyze their reasoning in no other way than as here given. (Compare with Rankine, "Civil Engineering," p. 227.)

3. Another point (which appears in Professor Johnson's discussion of Estrada's paper) is that one wherein it is assumed that the product of a static load and its resultant stretch is the measure of the dynamic shock which will produce the same effect. This seems to rest on nothing more substantial than the bare fact that dynamic shock is expressed in foot-pounds; and the work of a static force being the product of feet × pounds is also expressed in foot-pounds. The argument seems to be that because W lbs. × E ft. = WE ft.-lbs., therefore, a dynamic shock of WE ft.-lbs. will produce the same effect as the static load W. This is equivalent to saying that W = WE.

The logic is bad. There is no connection whatever between the premises and the conclusion. The relation between the dynamic blow and the static pressure is not known, although it has been the subject of much research and study; and a static test will not reveal the specific amount of shock that the material will sustain. We know in a general way that a brittle material will not endure shocks, and so far as static tests determine brittleness, we may determine the general fitness or unfitness of the material for this class of duty. Further than this we cannot go at present.

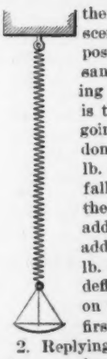
As the matter presents itself to the writer, the subject of resilience, as developed in our text-books, is vitiated by, not one, but several errors, which render it unworthy the name of science, and which make any application of its principles to the discussion of experiments in impact misleading and profitless.

Yours truly, Thos. H. Johnson.

Pittsburg, Pa., Aug. 22, 1894.

(Let us see if we can make clear a few of the points which seem so doubtful to our correspondent. In the first place, Mr. Johnson objects to the proposition that when a bar is strained within the elastic limit the work done on it increases in proportion to the square of the load. Let us see whether this is the case. Suppose a bar is subjected to a tensile strain in a testing machine by a pull of W pounds which stretches it a distance E. Then, says Mr. Johnson, the text-books declare that the work absorbed by the bar = WE. If they say this they are very bad text-books. The bar theoretically (and, within limits, practically) acts like a spring, the force applied begins at zero and gradually increases until it reaches W pounds. If this increase is uniform (and we suppose it to be), then the average load and average resistance exerted by the bar is ½ W, and the work done is ½ WE. Now suppose we apply the force 2W, the stretch will be 2E and the work done will be $\frac{2W}{2} \times 2E = 4\frac{WE}{2}$. Similarly, if the force 3W does not stretch the bar beyond the elastic limit, the stretch will be 3E and the work done will be $\frac{3W}{2} \times 3E = \frac{9WE}{2}$. According to this, the work done upon a bar when stretched within the elastic limit does appear to vary with the square of the load to which it is subjected. If our correspondent still has doubts, we suggest that he try the following experiment: Suspend from a fixed support a long coil spring of steel wire and attach a pan to its lower end, as shown in the accompanying figure. Into this pan pour sand and note the deflection when 1 lb., 2 lbs., 3 lbs., etc., are poured in, taking care not to stretch the spring beyond the limit of elasticity. Then the work done upon the stretched spring is represented by the weight of each grain of sand multiplied by

THE LINCOLN TRESTLE DISASTER; VIEW OF WRECK LOOKING WEST.



the distance through which the pan descended after it was put in. Thus, suppose the pan drops 1 in. when 1 lb. of sand is in it. Then the average load during this descent was ½ lb., and ½ in.-lb. is the work done on the spring. Now, in going down the next inch the total work done on the spring is, first, that of the 1 lb. of sand already in the pan, which in falling an inch does 1 in.-lb. of work on the spring; second, the work done by the additional pound of sand put in to give the additional deflection, which gives ½ in.-lb. more, and, third (the spring in 2 ins. deflection), the ½ in.-lb. of work done on on the spring while deflecting through the first inch. Thus the total is 2 in.-lbs.

2. Replying to our correspondent's second criticism, we have never heard of a text-book which proved the theorem to which he refers in the way that he states. We will freely admit that Rankine's exposition is not so clear as is desirable; but Rankine wrote in the days when comparatively little heed was paid to clearness. To be enigmatical was regarded rather as proof of an author's great-

ness. To show what is meant by the text-books, let us go back to the spring and see what it can teach us. Suppose we slowly pour a pound of sand in the weight pan, as before, and find the deflection to be 1 in. Now take out the sand and put it in a bag. Then put the bag on the pan, and the instant it touches the pan let go. The pan will bob down under the suddenly applied load, and were internal and external friction as absent as our theory supposes them to be, will reach the limit of 2 ins. That is what the text-books mean when they say that a suddenly applied load will produce twice the deflection of a load gradually applied. Of course the deflection is not permanent. The weight pan instantly bobs up again almost to the point of no deflection. In fact, had the spring that perfect elasticity and freedom from all friction which we usually suppose materials under strain to have in mathematical discussions, it would return quite to the point of zero deflection, and would go on bobbing up and down for ever.

3. We do not think Prof. J. B. Johnson, or any one else, will assert that because, let us say, a bar elongates 3 ins. under a slowly applied load of 10,000 lbs. that, therefore, a blow of 30,000 in.-lbs., all of which is absorbed by the bar, would stretch it exactly 3 ins. For no one can know for a certainty that force applied by a shock produces exactly the same internal action as force slowly applied. On the other hand, it does seem extremely probable that so long as the bar is not strained beyond the elastic limit its internal structure resists forces about the same, whether the force is applied suddenly or slowly. When the elastic limit is passed, however, it seems extremely probable that the bar may act quite differently under a shock than under a steady strain, although the difference is not likely to be so great that the product of ultimate strength and elongation under static load will not give an approximate idea of the shock it can resist.

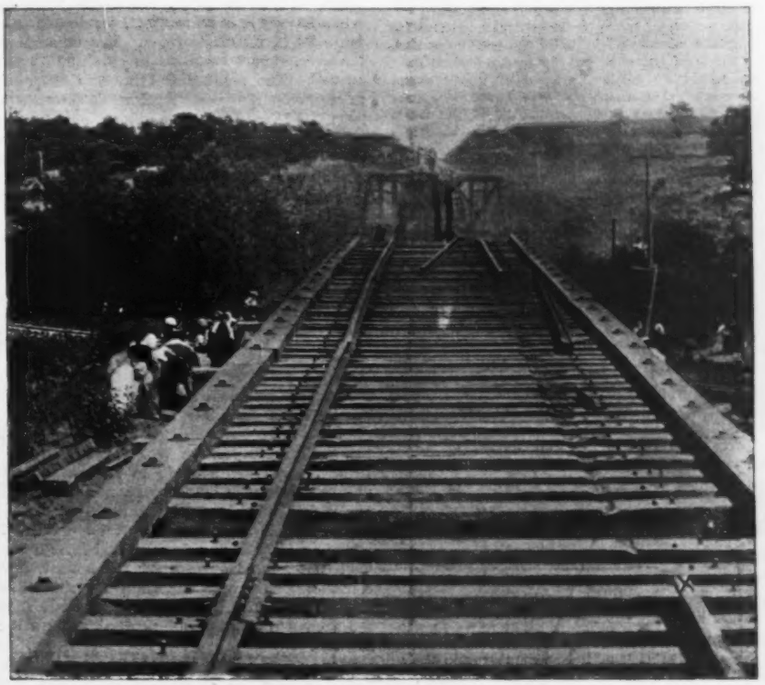
Of course this does not refer to brittle materials, in which the molecules are in a state of uneven tension, but only to materials in which uniform resistance of the molecules throughout the mass may be reasonably assumed.—Ed.)

THE LINCOLN TRESTLE DISASTER ON THE CHICAGO, ROCK ISLAND & PACIFIC RY.

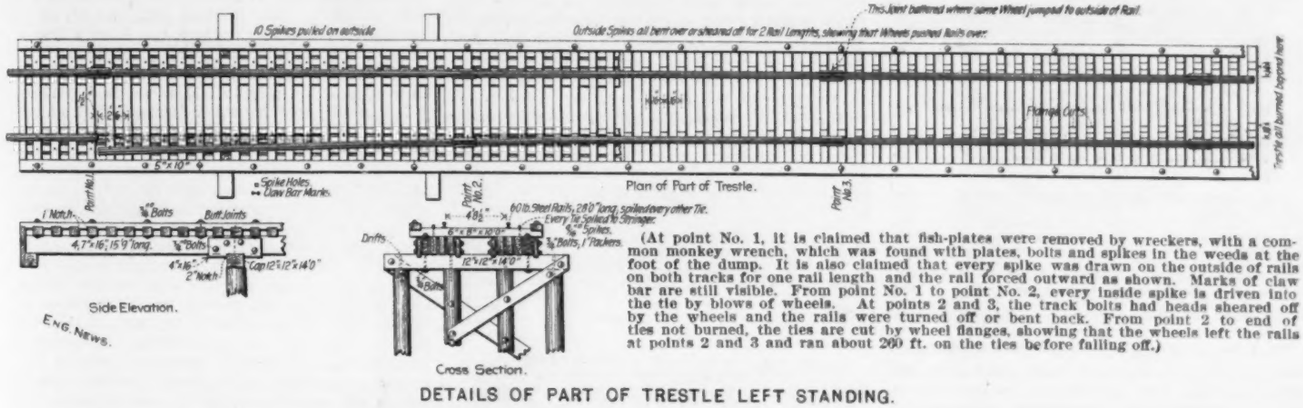
Sir: In your issue of Aug. 16, p. 123, I observed a brief record of the accident on the Chicago, Rock Island & Pacific Ry., near Lincoln, Neb., on Aug. 9, which resulted in the most serious loss of life that has occurred on any railway west of the Missouri River for many years. The idea came to the writer that something more than a casual mention of the disaster was due to the public and the profession from means whereby a recurrence of similar accidents under similar circumstances might be avoided, or at least reduced to the minimum.

Perhaps the editor himself will devote a few minutes of his valuable time to giving his readers the benefit of his opinions and experiences in such cases as the one in question. The writer ventures the statement that there are no very new conditions connected with this accident, aside from the asserted removal of fish-plates, bolts and spikes, by supposed train wreckers.

This being admitted as a fact the remaining conditions may be briefly stated as follows: A pine and oak timber structure of good proportions carried a single-track, standard gage railway across a somewhat isolated timbered ravine 500 ft. in width, at the bottom of which, beneath said structure, pass two main lines of the Union Pacific Ry. The structure was fairly well braced and fastened. The stringers were of ample size to carry the heaviest engines. The ties were 6 × 8-in. oak spaced 16 ins. c. to c. The guard rails were on the outer ends of the ties, as shown in the engravings. There were no inside guards or safety appliances, no provision against fire from trains passing beneath the structure, and no watchman or track-walker on the bridge. The questions that naturally pass through the engineer's mind are somewhat after this fashion: "Do the location and sur-

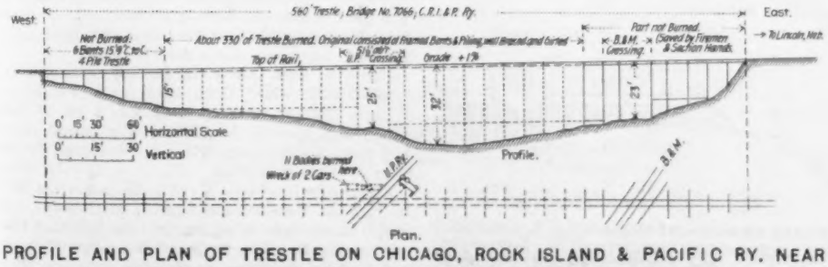


THE LINCOLN TRESTLE DISASTER; VIEW OF TRACK NEAR END OF TRESTLE WHERE DERAILMENT OCCURRED; LOOKING EAST.
Splices Removed by Wreckers, X. Outside Spikes Removed by Wreckers, ⋮.



(At point No. 1, it is claimed that fish-plates were removed by wreckers, with a common monkey wrench, which was found with plates, bolts and spikes in the weeds at the foot of the dump. It is also claimed that every spike was drawn on the outside of rails on both tracks for one rail length and the rail forced outward as shown. Marks of claw bar are still visible. From point No. 1 to point No. 2, every inside spike is driven into the tie by blows of wheels. At points 2 and 3, the track bolts had heads sheared off by the wheels and the rails were turned off or bent back. From point 2 to end of ties not burned, the ties are cut by wheel flanges, showing that the wheels left the rails at points 2 and 3 and ran about 200 ft. on the ties before falling off.)

DETAILS OF PART OF TRESTLE LEFT STANDING.



PROFILE AND PLAN OF TRESTLE ON CHICAGO, ROCK ISLAND & PACIFIC RY. NEAR LINCOLN, NEB., BURNED WITH TRAIN WRECK ON AUG. 9.

roundings demand other than ordinary periodical attention, such as is given to the balance of timber structures on the road? Do good practice and a reasonable degree of safety to the travelling public demand inside guard rails and re-railing appliances on a structure of such dimensions and character?

From the action of the train after derailment, as indicated by the marks of wheels on the remaining ties, and the distance travelled on the bridge before final ditching, would an efficient system of inside guard rails have guided the wheels across the structure with an even chance of being replaced on the track at the other end if re-railing devices had been there?

Would this train, consisting of a 35-ton locomotive and two cars, running 40 miles per hour and striking the misplaced rail, as shown, and being guided over by the inside guards, have probably been brought to a stop in the length of the bridge—560 ft.?

With efficient inside guards securely fastened, would train wreckers probably venture to take time enough to disconnect a sufficient amount of track system to ensure the ditching of a train?

These are important queries and worthy of more than a passing notice, and the writer will feel repaid for the pains he has taken to look the matter up if engineers interested in such matters would express their views on the above questions through your columns.

Yours truly, C. E. H. Campbell.

Council Bluffs, Ia., Aug. 23, 1894.

(We are much indebted to our correspondent for his interesting particulars of the disaster and his discussion of the features in connection with it, which must interest engineers. And yet our own views, for which he asks, were pretty well expressed in an editorial note in our issue of Aug. 16, as follows:

It is a special aim of this journal to obtain and publish full reports of all failures of engineering works where the failure teaches any lesson by which its readers may profit. Of course many disasters to which the newspapers devote much space are due to causes with which engineers have little or nothing to do. The recent terrible railway accident in Nebraska, caused by train wreckers, is a matter which chiefly concerns those who make and enforce the laws, and little interest attaches to it from an engineering point of view.

We fully agree that the bridge floor would have been very much bettered by inside guard rails and re-railing guards, but that such a change in construction would have necessarily or probably thwarted the designs of the fiends in human form who are responsible for this holocaust does not seem at all certain. It is familiar knowledge that a large proportion of train wrecking is done at switches and frogs, where it is easy to wedge an obstruction between the rails; and it might be that the train wreckers would have done their deadly work still more easily and effectually by wedging the space between the track rail and the guard rail. Practically a railway is of necessity vulnerable in a thousand places to the attacks of those who would wreck its trains or destroy its property. There ought to be little difficulty in securing the passage of laws making train wrecking a capital offence; and this has already been done in California. —Ed.)

CROSS-SECTIONS OF RAILWAY ROADBEDS.*

The width of roadbed (by which is meant the surface at subgrade) is from 26 to 32 ft. for double track and 14 to 18 ft. for single track on fills, while in cuts it is 28 to 32 ft. for double track and 18 to 22 ft. for single track. The minimum width, however, should be 20 ft. in cuts and 15 to 16 ft. on fills. The roadbed is formed in different ways to throw off the water reaching it through the ballast: (1) It may have one or more planes from each side to the center; (2) it may have a curve with a rise of 3 to 6 ins. for single track or 6 to 8 ins. for double track, or (3), it may have a flat center portion with planes each side to the ditch. In regions of ordinary rainfall the best plan is to give a slope, as it will throw off water better than a flat curve.

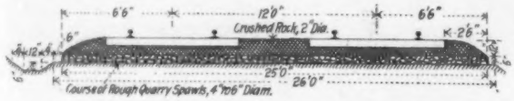


Fig. 1. New York Central & Hudson River R.R.

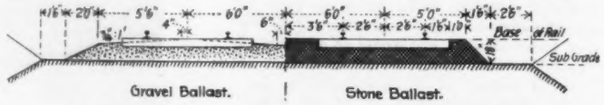


Fig. 3. New York, New Haven & Hartford R. R.

The latest specifications prepared by Mr. Walter Katte, Chief Engineer of the New York Central R. R., require the subgrade to be as nearly homogeneous in composition and consistency as practicable, for a depth of 18 to 24 ins., solidified to uniform resistance by thorough ramming or rolling, and truly graded in regular drainage planes, having a rise of 6 ins. for a double track roadbed 27 ft. wide in a fill. Such a roadbed will form a firm and well consolidated surface for the ballast, and this consolidation is very important for efficient drainage. These different forms of section are shown in the accompanying cuts of roadbed and track cross-sections.

In some cases the slope of the roadbed is continued to meet the toe of the slope in cuts, but with earth or other poor ballast, and in country with ordinary rainfall it is better to have a ditch reaching well below subgrade, so as to effectually drain the roadbed. The drainage of the track is effected by the ballast, the crowning of the subgrade and by side ditches in cuts, which latter carry away the water from the ballast and roadbed, and this drainage is one of the most important items in maintaining a good track, its importance increasing as the quality or quantity of the ballast decreases, and increasing also in relation to the extent of rainfall. With earth or mud ballast, good drainage is absolutely essential to enable the track to be kept in safe and fairly good condition, as water-soaked earth becomes pasty and unmanageable, impossible to tamp and put in condition. Stone and slag ballast drain readily, but gravel, burnt clay, sand, earth, etc., will retain water more or less (according to quality) and will heave in frosty weather. A good depth of ballast will greatly facilitate maintenance by keeping the beds of the ties well drained, and it is a mistaken policy to economize in ballast. In fact, it is an excellent plan for roads to own gravel pits and keep working them.

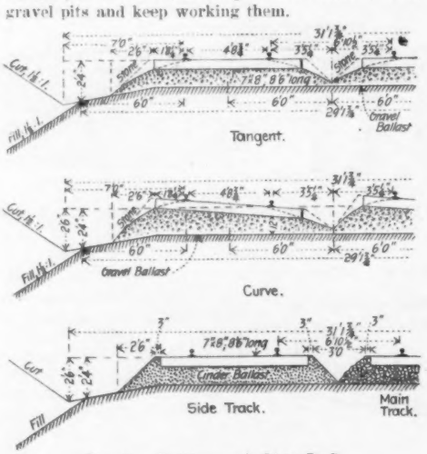


Fig. 5. Baltimore & Ohio R. R.

Climatic conditions, of course, are to be considered in designing the form of cross-section of roadbed, heavy ditching not being required in dry regions with light soil. On roads through country with a moderate rainfall the ditches should, nevertheless, be of ample capacity to carry off storm water in occasional heavy rains. The ditches should be parallel with the track, not made to wind around stumps or boulders, and must be graded so as to pass all water freely and to thoroughly drain the roadbed and keep both ballast and roadbed firm and dry. The width should increase towards the ends, and if the standard width does not give sufficient capacity, the ditch should be widened on the outer side. The distance from the rail to the ditch varies according to the nature of the soil, and the bottom should be about 18 to 24 ins. below the bottom of ties. An average arrangement in ordinary material is a distance of 7 ft. from the rail to the edge of a ditch 24 ins. wide on top, 18 ins. wide on the bottom, with bottom 8 ins. below center of roadbed on single track and 11 ins. on double track. In wet cuts the ditches may be lined with cement, or, in narrow cuts (especially where the earth slides or bulges), they may be lined with plank or old ties, with struts across the top. Subdrains of tile, laid in wooden boxes, may be laid as required. Where it is necessary to carry water from the ditch on one side to the ditch on the other, box drains of wood are laid in the ballast. These box drains are usually 12 × 12 ins. wide, 12 to 16 ft. long, made of 2-in. plank, with the ends sloped to conform to the slope of the ballast, and having flat strips 2 × 6 × 12 ins. across the top. The ditches may be carried under road crossings by cast iron pipe, clay sewer pipe or a wooden box drain. The first, however, is preferable, as wood soon rots and lets dirt fall in to clog the drain and the clay pipe is liable to be broken, as there is generally very little cover over it. The size of pipe varies according to the amount of water, but is generally 6 to 10 ins., while the box drain is generally about 8 × 10 ins., having a plank bottom and sides and a top of cross strips nailed close together. In ditching the work should always be commenced at the lower end, so that it will drain itself. A ditching machine with a scoop hung from a derrick on a flat car is sometimes used, but as a rule the work is done by hand.

Fig. 6. Chicago, Burlington & Quincy R. R.

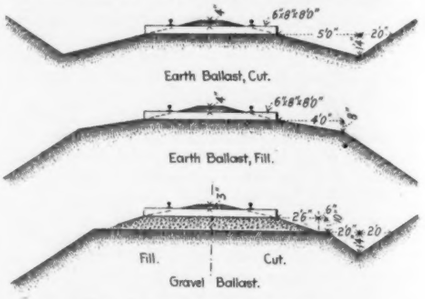


Fig. 7. Illinois Central R. R.

The New York Central R. R. (Fig. 1) makes its roadbed 26 ft. wide. Upon this is a 6-in. course, 25 ft. wide, of rough quarry spawls, 4 to 6 ins. in size, closely laid, like the foundation of a telford road, and upon this is 12 ins. of 2-in. broken stone, filled in to the tops of the ties.

The Pennsylvania R. R. (Fig. 2) has a roadbed 19 ft. 2 ins. wide for single track, 31 ft. 4 ins. for double track, 43 ft. 6 ins. for three, and 55 ft. 8 ins. for four tracks. The roadbed has a slope of 1 in. in 4 ft. from the center to the edge of ballast, and

Fig. 2. Pennsylvania R. R.

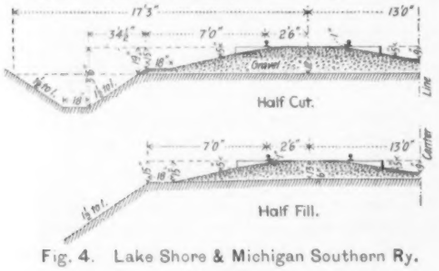


Fig. 4. Lake Shore & Michigan Southern Ry.

* Copyrighted, 1894, by Engineering News Publishing Co.

then a berme of 6 to 1 slope, 3 ft. 6 ins. wide, to the edge of ditch or bank. The ballast is 12 ft. 2 ins. wide for single track and 8 ins. deep under the ties. With more than one track, the stone ballast is filled in the full width of track, but gravel is sloped down between the tracks. The ballast is not shouldered out beyond ends of ties. In soft places cinder ballast is used until the roadbed has settled. It will be noticed that the standard section has a well formed ditch, but for single track with light traffic there is no ditch. The quantity of ballast in cubic yards per mile is as follows:

	One track.	Two tracks.	Three tracks.	Four tracks.
Stone	2,315	5,300	8,500	12,260
Gravel	1,900	4,075	6,950	10,185

The New York, New Haven & Hartford R. R.

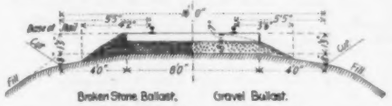


Fig. 8. Southern Pacific Ry.

(Fig. 3) has a flat roadbed 30 ft. wide for double track, with no ditch. Stone ballast is level with the tops of the ties and shouldered out 12 ins. at the ends, while gravel ballast is sloped to 4 ins. below the top of the ties at their ends, forming a ditch between tracks on double track, with long water boxes at intervals to carry the water to the sides.

The Lake Shore & Michigan Southern Ry. (Fig. 4) has a roadbed 32 ft. wide for double track, or 47 ft. 6 ins. over ditches in cuts. The gravel ballast is sloped down between the tracks, and in cuts it is filled out to the edge of the ditch. The ballast is 12 ins. deep under the ties in cuts and 6 ins. on fills, and the quantity of ballast is as follows:

	Single track.	Double track.
On fills, cu. yd. per mile....	2,165	4,171
In cuts, " " " "	3,749	6,917

The Baltimore & Ohio R. R. (Fig. 5) has a single

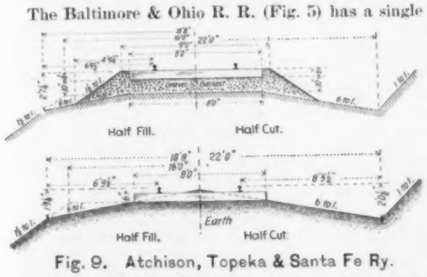


Fig. 9. Atchison, Topeka & Santa Fe Ry.

track roadbed 19 ft. 1½ ins. and 17 ft. 1½ ins. wide for cuts and fills respectively, and double track, 31 ft. 1¾ ins. and 29 ft. 1¾ ins., no ditches being used. Stone and cinder ballast (the latter for side tracks) are shouldered out 3 ins. beyond ends of ties, while gravel is given a rounded surface, touching the bottoms of the ends of the ties. The depth of ballast is 12 ins. under the ties, and on curves each track has its rail on a separate plane and the ballast is 12 ins. deep under the lower rail. Stone and gravel ballast is sloped down between the tracks.

The Chicago, Burlington & Quincy R. R. (Fig. 6) has a single-track roadbed 16 ft. wide with a rise

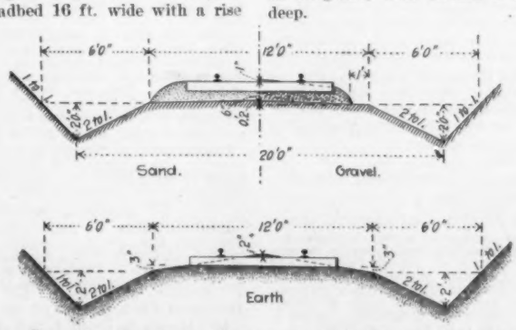


Fig. 10. St. Paul, Minneapolis & Sault Ste. Marie Ry.

of 4 ins. at the middle, and burnt clay ballast 8 ins. deep under the ends of the ties and shouldered out about 10 ins. The cut shows tile subdrains.

The Illinois Central R. R. (Fig. 7), in using earth ballast, fills it 4 ins. over the ties, flat on top and sloped down under the rail to the bottom of the tie at the end, extending thence 5 ft. to bottom of ditch

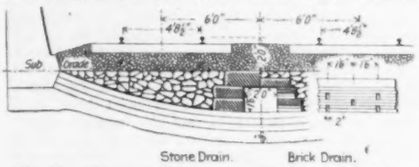


Fig. 11. Howard St. Tunnel; Baltimore Belt Ry.

or 4 ft. to edge of bank. With fine gravel the section is similar, but filled in only 3 ins. over the ties, 10 ins. deep under the ties and leaving 6 ins. between edge of ballast and edge of ditch or bank. Stone or coarse gravel is filled in level with tops of ties, 10 ins. deep under the ties and shouldered out 6 ins. beyond their ends, sloped 1½ to 1, with 6 ins. between edge of ballast and edge of ditch or bank.

The Southern Pacific Ry. (Fig. 8) has a single-track roadbed 18 ft. wide in cuts and in fills it is 15 ft., 14 ft. 6 ins. and 14 ft. for rock, gravel and earth ballast respectively. There is a depth of 8

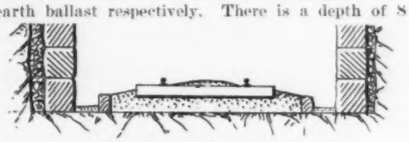


Fig. 12. Boulder Tunnel.

ins. of ballast under the middle of the tie. Rock ballast is shouldered out 6 ins. beyond end of ties and sloped 1 to 1. Gravel is filled in about 2 ins. over middle of ties and sloped nearly to the bottom of end of tie. Earth is filled in over the ties and sloped to bottom of ends, and thence sloped 12 to 1 to the top of the bank. At stations fine sand or engine cinders are filled in over the ties between rails and tracks. The edges of banks are rounded off.

The Atchison, Topeka & Santa Fe R. R. (Fig. 9) has a single-track roadbed 22 ft. wide in cuts and 18 ft. 8 ins. wide on fills. The ballast is 10 ins. deep under the ties and gravel and rock are level with the tops of the ties and shouldered out 6 ins. beyond their ends, the rock sloped 1 to 1. Burnt clay and cinders are formed the same as gravel. Earth is filled in over the ties and sloped to bottom of end and to edge of bank or cut.

The Minneapolis, St. Paul & Sault Ste. Marie Ry. (Fig. 10) has a single-track roadbed 12 ft. wide, crowned 0.2 ft., and having 6 ins. of ballast under the center of the ties. The width is 20 ft. c to c. of the ditches, which are 2 ft. deep. Gravel is filled in 1 in. over tie and sloped to 3 ins. below top of tie at ends, shouldered out 12 ins. beyond ends, leaving 12 ins. between ballast and edge of ditch. Sand is filled in level with top of ties, shouldered out 1 ft. and rounded off to the edge of ditch, an arrangement which seems likely to cause the sand to flow into the ditch. Earth or loam is filled in 2 ins. over tie and sloped under rail to bottom of tie at end, and thence to edge of ditch. In places where compelled to excavate to a depth of 1 to 3 ft. in sandy ground, the roadway was made 28 ft. base at subgrade, with ditches 8 ft. wide and 2½ ft. deep.

The Richmond & Danville R. R. standard single-track roadbed is 18 ft. wide between ties of slopes of cuts; the surface curved, with a rise of 8 ins. Rock ballast is laid to a depth of 8 ins. under the ties, the bottom of ditch being thus 16 ins. below the ties. The ballast is level with the tops of the ties and rounded off from their ends to a bottom width of 16 ft.

The Chicago & Alton R. R. slopes its roadbed with a rise of 3 ins. for single track and 5 ins. for double track, putting 10 ins. of stone or gravel ballast under the middle of the tie and shouldering it out 12 ins. beyond their ends, while between the tracks it is level with the ties.

The Richmond, Fredericksburg & Potomac Ry. has a single-track roadbed about 16 ft. wide, with gravel ballast sloped from edge of ditch to bottom of tie, leaving the ballast flat for 3 ft. 2 ins. between the rails. The ditch is formed by a slope from the roadbed to edge of slope of cut, the bottom being 30 ins. below top of tie and 20 ins. from edge of roadbed. The gravel ballast is 10 ins. deep under the ties.

The Cleveland, Cincinnati, Chicago & St. Louis Ry. has a somewhat unusual cross-section of track with broken stone and gravel ballast. (Eng. News, May 17, 1894.) Stone ballast, as a rule, is filled in level with the tops of the ties for the entire length of the ties and then either sloped down from the end or shouldered out for 3 to 12 ins. beyond the ends, but in this case it is sloped, like gravel, from inside the rails to bottom of tie at the ends and hence to roadbed, the slope being much flatter than that usually adopted for stone. The gravel ballast is sloped in the same way, leaving the top flat for a width of over 4 ft., though it is more common practice to commence the slope near the middle of the track. On double track the gravel is sloped down between the tracks, leaving about 3 ins. of ballast at the lowest point.

The Lehigh Valley Ry., on its new Buffalo line,

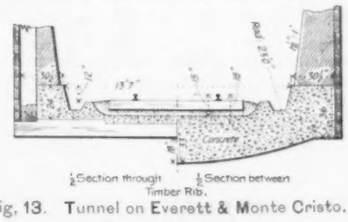


Fig. 13. Tunnel on Everett & Monte Cristo.

has a roadbed 28 ft. wide in cuts and on fills, with a V-shaped ditch 8 ins. deep, making the width over ditches in cuts 32 ft. The stone or slag ballast is 2 ft. deep, level with tops of ties and rounded off from their ends. (Eng. News, June 21, 1894.)

In rock tunnels the floor is generally flat, sometimes with a trench drain down the middle, covered by flat stones to keep out the ballast, or else a pipe

Fig. 14. St. Clair Tunnel.

drain is laid in the trench and the ballast filled round it. With this arrangement the ballast is usually filled in level with the ties for the full width of the tunnel, but if there is no drain, the ballast may be sloped in the usual way to form side and center ditches. If the tunnel has an invert, there is usually an arched or box drain of brick or dry stone masonry built upon it and covered by the ballast, though sometimes a pipe drain is laid in the ballast. The designs for brick and stone drains in the Howard St. tunnel of the Baltimore Belt Ry. are shown in Fig. 11. In single-track tunnels the floor may be flat or may have center or side drains. Figs. 12 and 13 show the arrangements adopted for the Boulder tunnel (Montana Central Ry.) and in the tunnels of the Everett & Monte Cristo Ry. Fig. 14 shows the arrangement in the St. Clair circular iron-lined tunnel of the Grand Trunk Ry. Masonry viaducts usually have drains leading to weeper holes or pipes forming outlets at the haunches of the arches, either at the spandrel or the intrados.

In yards there should be an ample depth of good ballast, with drains or water boxes leading to main drains, and these drains should be carefully cleaned and put in order just before winter.

Selling current for power purposes from the circuits of electric trolley lines is said to be quite common in the Western states. This is done in spite of the fact that the charters of the street railway companies forbid the use of electricity for other purposes than for the operation of the cars. The increase in fire hazards which is claimed to result from the practice has attracted the attention of fire insurance companies to this misuse of privileges and the Lancashire Insurance Co. has compiled a list of cities and towns in the West where electric current is thus sold. According to this list, out of 145 Western cities having electric street railways, there are 68 in which the companies sell electric current to private users directly from the trolley wires, and they do this because they can afford to sell it cheaper than regularly organized light and power companies. In Toledo, St. Joseph and Cairo the insurance agents have already passed resolutions canceling policies in case the practice is continued.

Analyses of water from the new filter beds at Mount Vernon, N. Y. (see Eng. News, Aug. 23, 1894), show a reduction of 99.2% of the bacteria and 66% of the albuminoid ammonia. The filter beds were put in operation on Aug. 1 and the samples were taken Aug. 20, the beds having been idle two days meanwhile on account of some work necessary for their completion or repair. The chemical analyses were made by Mr. H. W. Clark and the bacteriological examinations by Mr. Geo. W. Fuller, of Lawrence, Mass. The filter beds are in many respects similar to those connected with the city water supply of Lawrence, described in Engineering News of Aug. 3, 1893. In our issue of Aug. 23 the sand used at Mount Vernon was spoken of as coarse. Mr. J. N. Chester, Constructing Engineer, states that he believes the sand is as fine as that used at Lawrence.

A canal to connect the waterways of Jackson and Washington parks, Chicago, is now being dug under the direction of the South Park Commissioners. Work is now in progress through the ground occupied last year for the Midway Plaisance, the location of the Ferris Wheel having been reached at the last report.

The Pennsylvania Flood Commission has awarded to the engineering firm of Webb & Perkins, of Williamsport, Pa., a contract for surveying the West Branch watershed with a view to the protection of Williamsport against future floods. The territory involved is about 16 miles long by 2 miles wide, and the survey is to extend to a plane 45 ft. above the normal level of the Susquehanna River.

Heliographic signaling is to be attempted with two sets of mirrors over a line 183 miles long, by Capt. W. A. Glasford, Chief Signal Officer of the Department of the Colorado. The points selected are Mount Uncompahgre, in Southern Colorado, and Mount Ellen, in Utah; the first being 14,351 ft. and the other, 11,410 ft. above sea level. Their summits are visible from each other on clear days, and the atmospheric conditions in this arid region are peculiarly favorable to an attempt of the kind proposed. It is the longest line of heliographic signals ever tried by the Department. A preliminary test was made by the same party, on Sept. 3, by flashing signals from the top of the Equitable Building, in Denver, to Pike's Peak, a distance of 66 miles. The flashes of the mirrors on Pike's Peak could be distinctly seen by the naked eye in Denver.

An electric railway, 50 miles long, is proposed between Baltimore and Gettysburg, Pa. The present steam railway between the same points is very crooked and 72 miles long. The proposed electric line would follow the present railway to Westminster, Md., and then cross the country to Littlestown and on to Gettysburg. Of the new line, 7 miles, from Druid Hill Park, in Baltimore, to Pikesville, have been in operation since 1892, and 9 miles more, from Pikesville to Reistersville, were put under contract for construction within the last two weeks. Several miles of an electric railway, from Gettysburg across the famous battlefield, are also in operation, and would form part of the new system.

Forty locomotives, with "cut-water" shaped shields in front of the boiler, with smokestack, dome, cab, etc., also similarly wedge-shaped, are being built for the Paris, Lyons & Mediterranean Railway Co. "The Engineer," of London, doubts if much more than excessive ugliness will result from the new designs, as English experiments show that trains with the front and hind vehicles so shaped show hardly any decreased resistance. The side resistance, or friction, is the principal cause of loss of effect.

A proposition to build a new court-house in Chicago has been made to the County Commissioners of Cook Co., by the George A. Fuller Company of that city. The building is designed by architect Henry Ives Cobb; would be 14 stories high and the estimated cost is $4,832,000, to be paid in 4% twenty-year county bonds. The new building would occupy the site of the present county court-house, which is practically condemned as unsafe, unsuited to its purposes and in a very bad sanitary condition. Besides all the offices necessary for the many county officials the county would have in the new building seven or eight floors of modern offices to be rented to individuals. The proposers of the plan claim that a revenue of $350,000 to $400,000 per annum could be gathered from these offices, a sum sufficient to pay the interest on the bonds and create a sinking fund that will pay off the bonds in 20 years. The county would thus obtain a new and entirely satisfactory court-house that would pay for itself and at the end of 20 years yield a handsome revenue in addition. The proposition is a novel one and is under consideration by the County Commissioners.

If larger telescopes can tell us more of our planet neighbors, the immediate future promises well. The 36-in. Lick telescope, on Mount Hamilton, Cal., is now the largest in use. But the 42-in. object glass of the Yerkes telescope for the Chicago University has been finished, and Mr. John A. Brashear, of Pittsburg, Pa., is at work on a 50-in. object glass for a telescope, to be presented to the Allegheny Observatory by Andrew Carnegie and Henry Phipps, Jr. A 37½-in. lens is also being now made for the Lowe observatory, at Mount Lowe, Southern California; and the 38-in. lens for the Chamberlain observatory, at Denver, Colo., it is said, was finished this month at the establishment of George Saegmuller, at Washington, D. C. The latter is to be mounted at once, and will be ready for use before any of the others.

A run of 780 miles in 880 minutes, stops deducted, is reported as having been made between Jacksonville, Fla., and Washington, D. C., an Aug. 26-27. The fastest time made was 96 miles in 99½ minutes, between Ashley Junction and Florence, this time including two stops. The train was a special carrying an excursion.

A break occurred on the Erie Canal Aug. 28, at Brighton, N. Y. The report of Division Engineer Bisgood to Mr. C. W. Adams, State Engineer and Surveyor, describes the accident as follows, Mr. Adams having kindly furnished us with the information:

The break occurred in the towpath, about 250 yds. east of Miller's Lock (63) in Brighton (called the three-mile level), at 10 p. m. on Aug. 28. It was about 50 ft. long on top, 20 ft. wide at bottom and about 15 ft. in depth, and had an average width of 45 ft. A temporary cofferdam was put in that night and next morning we commenced filling the gap with teams, and finished at noon on Friday, Aug. 31. In the meantime the water was running by break in canal at 7 a. m., so the levels east would be filled up. The cost of repairs is about $2,200, but the damage to farm lands cannot be ascertained until a survey is made and experts go with the party to value the crops. There are some nurseries which the water passed through, and probably the damages will be the greatest there. From former breaks I think $10,000 will cover all damages.

Our attention has been called to an error in the article on "Mechanical Filters at New Orleans" in our issue of Aug. 30. The first sentence on the top of p. 175 should read as follows: During my stay the filters had to be washed every four hours.

Plans for a lighthouse, on the Diamond Shoal, off Cape Hatteras, are about completed by the Lighthouse Board at Washington, D. C. In the original attempt of some years ago, a large caisson was to be sunk 120 ft. below the water surface, through the treacherous sands. This attempt failed owing to the prevailing heavy seas, and imperfect records of soundings on the shoal. The new plan contemplates a screw-pile foundation, about 100 ft. deep, with an open framed structure resting upon it and rising about 160 ft. above the surface. This Diamond Shoal extends 14 miles off Hatteras and the light would be founded on the outer edge. There is considerable doubt as to the practicability of founding any light on these shifting sands in a heavy sea prevailing throughout the year. But the light is badly needed and it seems that the trial is to be again made; of successful, it will mean the accomplishment of one of the most difficult pieces of lighthouse engineering ever attempted.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Liability of Officers of Municipal Corporations.

The superintendent of streets of a city is liable for any damages resulting from his negligence in repairing a sewer, notwithstanding his official capacity. If the cost of making the repairs needed on the sewer exceed $100, the superintendent of streets had no jurisdiction to do the work, and would be liable for damages unless he did it skillfully and diligently.—Butler v. Ashworth (Supr. Ct. of Cal.), 36 Pac. Rep., 922.

Liability of Municipal Corporations for Defective Streets.

A village which has granted the right to construct a street railway is chargeable with knowledge of what is being done under the grant, and therefore, is liable for injuries caused by an excavation left at night without signal lights or guards, though the excavation was made on the day of the injury.—Hoyer v. Village of North Tonawanda (Supr. Ct., Gen. Term), 29 N. Y. Supp., 650.

Damages Incident to Performance of Contract.

A contract for the construction of a sewer for a city provided that the materials used should be strictly in accordance with the plans and specifications, and authorized the city to appoint such person or persons to inspect the materials as might be deemed proper. A difference of opinion between the contractors and the inspector as to whether materials provided for the work conformed to the specifications was an incident contemplated by the terms of the contract, and therefore they could recover damages for delay in performing the work occasioned by the rejection by the inspector, in good faith, of materials which conformed with the specifications.—Montgomery v. Mayor, etc., of City of New York (Supr. Ct. of N. Y. City, General Term), 20 N. Y. Supp. Rep., 687.

Conflicting Survey for Railway Right of Way.

A railway company which surveys an extension of its line over public lands beyond one of the termini fixed by its charter, and afterwards files supplemental articles of incorporation, authorizing it to make the extension, acquires by such survey no right of way, under the act of March 3, 1875, as against another company, which, having full powers, makes a survey over the same land after the former company's survey, but before the filing of its supplemental articles. The filing of a map of the route selected, under this act, and the approval by the Secretary of the Interior, do not prevent the company from afterwards, and within the time allowed by law, adopting a different route, so long as the rights of others have not intervened; and this without regard to the rules and regulations of the Department of the Interior.—Washington & I. R. Co. v. Coeur d'Alene R. & Nav. Co. (Circuit Court of Appeals, Ninth Circuit), 60 Fed. Rep., 981.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

CHICAGO & NORTHWESTERN.—A press report states that the engineers of this company are surveying for an 11-mile extension from a point northwest of Brampton to Gladstone, Mich.

GRAND TRUNK.—The Owen Sound branch of this road has been opened for traffic. It extends from Park Head on the Georgian Bay to Owen Sound, a distance of 14 miles.

PENNSYLVANIA.—It is stated that this company has definitely located the route for the Elkton, Massey's & Middletown road into Elkton, Md., and that the construction will be commenced within a few weeks.

TORONTO, HAMILTON & BUFFALO.—J. N. Young, Gen. Agt., Brantford, Ont., is reported to have stated to Mayor Stewart, of Hamilton, that the money for the construction of this road has been secured and that if the taxpayers vote a bonus of $275,000 for the third time the road from Brantford to Hamilton will be built by Jan. 1. The line is now in operation from Brantford to Waterford, Ont., 17 miles.

Projects and Surveys.

KEYSTONE & NORTHERN.—It is stated that surveys are being made for this road which was projected about a year ago from near Elwood City, Pa., to Wurtemburg and thence to Slippery Rock Valley.

Southern—Existing Roads.

BIRMINGHAM, SHEFFIELD & TENNESSEE RIVER.—Surveys are now being made for extending this road from Parrish, Ala., the present southern terminus, to Birmingham, a distance of about 40 miles. Pres., E. A. Hopkins, Sheffield, Ala.

Northwest—Existing Roads.

CHICAGO, PADUCAH & MEMPHIS.—This road was completed to Benton, Ill., last week.

ILLINOIS CENTRAL.—Press reports state that this company has awarded the contract for grading an extension from Onawa, Ia., to Council Bluffs, and that the construction will be commenced at once.

Projects and Surveys.

ST. LOUIS & ATLANTIC.—Incorporated in Illinois to construct a railway from East St. Louis through St. Clair, Madison, Clinton and Marion counties; Pres., T. L. Fekete; Vice-Pres., E. C. Rodes; Secy., W. E. Beckwith.

Southwest—Existing Roads.

SAN ANTONIO & GULF SHORE.—It is stated that 20 gangs of graders are working on this road and that the company has recently purchased 90 miles of steel rails.

TEXARKANA & SHREVEPORT.—A press report states that this company has contracted with a St. Louis firm for the construction of an iron bridge across Sulphur River at Fort Lynn, the present southern terminus of the road, and that it is understood that the construction of the line to Shreveport, a distance of 50 miles, will be commenced at an early date.

Rocky Mt. and Pacific—Existing Roads.

FLORENCE & CRIPPLE CREEK.—The chief engineer of this company is reported as in charge of a corps of engineers that is surveying for a railway from Florence, Colo., to Silver Cliff.

Projects and Surveys.

MARSHFIELD & PENINSULAR.—Incorporated at Portland, Ore., with a capital stock of $100,000 to build a railway from the northern terminus of the Coos Bay, Rosebury & Eastern in a northerly direction to North Bend and Coos Bay; incorporators, Capt. T. W. Symons, U. S. Engr.; Lee Hoffman, contractor; Sanderson Reed, lawyer, all of Portland.

UTAH.—H. S. Josephs, Salt Lake City, is reported as making surveys for a railway from American Fork to the hot springs on the north side of Utah Lake, a distance of 5½ miles. The road will be standard gage and laid with 30-lb. rails. These hot springs are owned by John Beck.

WHITE & COLUMBIA RIVER.—C. W. Joynt,

Pres., Buckley, Wash., writes us that five miles of this road have been definitely located from Buckley east along the White River, and that preliminary surveys have been made for an additional seven miles. The work is mountainous but the grades are light. The road will be used principally for logging purposes. The tracklaying will probably be commenced in November and the line opened for traffic by next January. It will eventually be extended to the Columbia River through Natchese Pass in the Cascade Mountains; also to Puget Sound.

Foreign.

MEXICAN INTERNATIONAL.—Press reports state that C. P. Huntington, Pres., has ordered that this railway be immediately extended from Monclove to the Sierra Mojado mining camp. Nearly all of the grade of the extension was completed about two years ago, but work was suspended owing to financial depression. A branch of the road is also being built from Reata to Monterey.

MEXICAN, CUERNAVACA & PACIFIC.—This road is now completed to a point beyond La Cigal, the summit of the Sierra Madre Mountains, and the contractors are pushing the construction as fast as possible so as to have it finished to the city of Cuernavaca by the time the tourist season sets in. Press reports state that J. H. Hampson, Kansas City, Pres. and Gen. Man., will leave in a few days for the United States to purchase several engines, 100 wood cars and 50 box cars.

MONTEREY & MEXICAN GULF.—It is stated that J. A. Robinson, Gen. Man., is now in New York arranging for the extension of this road from Trevino to Sierra Mojado, and thence to Port Mazatlan, on the Pacific coast.

STREET AND ELECTRIC RAILWAYS.

ASHFIELD, MASS.—It is reported that arrangements are being made for an electric railway between this place and Shelburne Falls.

EAST HARTFORD, CONN.—Fred T. Ley & Co., Springfield, Mass., have been awarded a contract for furnishing material and constructing an electric railway from this city to Manchester, a distance of about six miles.

HEMPSTEAD, N. Y.—The Hempstead Traction Co. has been incorporated to construct a line four miles long; capital stock, $50,000; directors, C. L. Barber, M. C. Palmer, New York; J. F. Davis, Brooklyn; J. S. Lawrence, Hempstead.

SYRACUSE, N. Y.—The Syracuse & East Side Ry. Co. has been incorporated to construct a line to DeWitt, a distance of 10 miles; capital stock, $20,000; directors, G. B. Leonard, F. R. Hazard, Syracuse; J. L. Kyne, East Syracuse; C. D. Beebe, Dansville.

BANGOR, PA.—It is reported that the Easton & Bangor Electric Ry. is to be extended to Martin's Creek, and that the surveys are now being made.

BRISTOL, PA.—Charles Davis, Ch. Engr., is making surveys for the proposed Bristol & Newtown Passenger Ry. The road will be built to Langhorne at present, and it is probable that the remainder of the line will not be constructed until the Doylestown & Newtown road is finished, when the two will make an electric railway from this city to Doylestown.

COLUMBIA, PA.—Arrangements are being made for an electric railway from Lancaster to this place, passing through Rohrerstown, Silver Spring and Ironville.

HARRISBURG, PA.—The Riverside Electric Ry. Co. has been incorporated with a capital stock of $50,000, to build a line between this place and Fort Hunter. Pres., W. K. Aldricks.

LANCASTER, PA.—The Lancaster Ry. Construction Co., noted Aug. 16 as incorporated, has been awarded the contract to build and completely equip 43 miles of electric railway in Lancaster county. The road will be built for the Pennsylvania Traction Co., and was noted in our issue of July 26. Pres., Henry Baumgardner; Vice-Pres., Michael Reilly; Secy., F. H. Stacy; Treas., J. E. Hubley; Supt. of Construction, H. E. Crilly.

MILTON, PA.—The Milton & Lewisburg St. Ry. Co. has been incorporated with a capital stock of $36,000; Pres., B. H. Throop, Scranton.

PITTSBURG, PA.—The Charlerol, California & Brownsville Electric St. Ry. Co. has been incorporated with a capital stock of $70,000. Pres., J. S. McKean. —R. L. McCully has completed surveys for the Pittsburg & Mount Lebanon Electric Ry.; length, seven miles; estimated cost, $100,000.

ROYERSFORD, PA.—The Sanatoga, Royersford & Collegeville Electric Ry. Co. has been incorporated with a capital stock of $150,000; Pres., J. C. Lynch.

KENSINGTON, MD.—Van Aken & Hays, Washington, D. C., have been awarded the contract for the grading, masonry and timber work on a two-mile extension of the Kensington & Chevy Chase Electric Ry. Ch. Engr., Morris Hacker.

CHARLOTTESVILLE, VA.—The Piedmont Construction & Improvement Co. has been granted a franchise for extending the electric railway. Pres., J. E. Willard; Gen. Man., T. O. Troy.

CINCINNATI, O.—The Cincinnati, Middletown & Dayton Traction Co. has been granted a franchise by the commissioners of Butler county to build an electric railway through that county along the Hamilton, Springfield and Carthage turnpike.

MANSFIELD, O.—Surveys are being made for an electric railway between this place, Shelby and Galion. A company is soon to be incorporated with a capital stock of $200,000, according to reports, to build the road.

BRAZIL, IND.—The Terre Haute & Brazil Electric Ry. Co., recently incorporated, is to construct a railway 12½ miles in length, estimated to cost $100,000 to $110,000. W. H. White and J. G. Elder, Terre Haute, are interested.

SOUTH BEND, IND.—J. McM. Smith, of the General Power & Quick Transit Co., of this city, has been granted a franchise to build an electric railway connecting Mishawaka and South Bend, running along the south bank of St. Joseph River.

BUCHANAN, MICH.—Surveys have been completed for an electric railway from this place to St. Joseph.

CHICAGO, ILL.—The Southwestern Suburban Rapid Transit Co. has been incorporated with a capital stock of $1,000,000, by A. H. Minassian, Newton Wilcoxon and F. M. Sherman.

WAUKEGAN, ILL.—The Bluff City Electric St. Ry. Co., recently incorporated with a capital stock of $200,000, is making arrangements to construct an electric railway to South Waukegan. D. L. Jones and S. D. Talcott are interested.

WAUKESHA, WIS.—The Waukesha Beach Ry. Co. has been formed with a capital stock of $75,000, by A. M. Jones, W. P. Sawyer and others. Surveys are being made for the proposed line to Pewaukee Lake.

VERNONIA, ORE.—The citizens of the Nehalem Valley are discussing the question of a proposed electric railway from Portland through Oregon City to this place, a distance of 50 miles. John Pringle, Martin Manning and Sidney Bell are interested.

WINNIPEG, MAN.—The Winnipeg Electric Ry. Co. is reported as making arrangements to increase the power of its plant.

BRIDGES AND TUNNELS.

PHILADELPHIA, PA.—James H. Windrim, Dir. Pub. Wks., has awarded the contract for the bridge at Wayne Ave. to the Mills Construction Co., at $50,000, and that for the bridge at 63d St. to I. H. Hathaway & Co., at $21,000; time for completing each, 3 months.

PITTSBURG, PA.—It is stated that the contract for constructing the 23d St. free bridge will be awarded as soon as some minor details in the plans have been changed. The bridge will have a channel span of 500 ft. and will cost about $300,000, according to reports.

BALTIMORE, MD.—Bids are asked until Sept. 19 for the construction of a bridge over railway tracks. Engr., F. H. Smith, Equitable Bldg.

HAMILTON, O.—The bridge commissioners received nearly 30 bids for the construction of the High and Main St. bridge. It is stated that the Smith Bridge Co., Toledo, submitted the lowest bids as follows: Superstructure, $36,900 to $44,500; substructure and superstructure, $84,000 to $108,000, according to plan. The Wrought Iron Bridge Co. bid $98,860, and the King Bridge Co. $98,000. The contract has not yet been awarded.

SANDUSKY, O.—Bids are asked until Sept. 18 for the construction of the stone arch bridge over Mill Creek. C. A. Judson, Engr.

CHICAGO, ILL.—The drainage board has completed specifications for three swing bridges to be erected across the canal at Willow Springs, Lemont and Romeo, at a cost of about $100,000 each.——Bids are asked until Oct. 31 for furnishing and erecting three swing or draw bridges and fixed spans along the line of the drainage canal; also for supplying and erecting the necessary masonry substructures, as stated in our advertising columns. Thos. F. Judge, Clk.

WEST SUPERIOR, WIS.—The city engineer has been instructed to prepare plans and to advertise for bids for proposed viaduct approaches on Belknap St.

FAIRBURY, NEB.—Bids are asked until Sept. 10 for the construction of an iron bridge across the Little Blue River; span, 100 ft; roadway, 16 ft. S. R. Merrell, County Clerk.

OMAHA, NEB.—The following bids were received for the construction of a wagon bridge across the Niobrara River near Fort Niobrara:

George E. King Bridge Co., Des Moines, Ia.	$5,300
Milwaukee Bridge & Iron Wks., Milwaukee, Wis.	6,750
Goodrich & Robson, Sioux City, Ia.	6,895
King Bridge Co., Cleveland, O.	7,395
St. Joseph Bridge & Iron Wks., St. Joseph, Mo.	7,850
Youngstown Bridge Co., Youngstown, O.	8,318
A. J. Tullock, Leavenworth, Kan.	8,900

ALTON, WASH.—It is stated that the bridge on the Washington division of the Oregon Ry. & Navigation Co.'s line near this place, which collapsed recently, will have to be entirely rebuilt, the bridge being 96 ft. high and 800 ft. long.

WATER-WORKS.

BURLINGTON, VT.—The city has authorized a loan of $20,000 for additional extensions.

MORRISVILLE, VT.—The village has voted not to purchase the local works, but to secure estimates for new works. Address G. M. Powers.

CAMBRIDGE, MASS.—The following persons submitted bids for the construction of the proposed reservoir at Payson Park, Belmont: Charles Linehan, Cambridge; Neil McBride, Brighton; Weaving, Booth & Parry Bros., Boston; Moulton & O'Mahoney, Boston; Arthur McMullen & Co., New York; William H. McHugh, Newton; Jones & Meehan, Jamaica Plain; Troy Public Wks. Co., Troy, N. Y.; R. A. Malone, Lancaster, Pa.; Cranford & Co., Brooklyn, N. Y.; David Hall, Boston; Conners & Co., Lowell; George M. Atkins & Co., Palmer; Leavitt, Daly & Crockett, Cambridge; National Construction Co., Boston; George R. Newman & Co., Providence; Clements & Stedeman, New York; Thomas Maney, Quincy. The contract has not yet been awarded.

MILLERS FALLS, MASS.—J. A. Taggart and Samuel Sawyer, of this village, and A. P. Carey, of Lake Pleasant, have been chosen a committee to petition the legislature for the incorporation of a district for a water supply.

BINGHAMTON, N. Y.—There is talk of constructing a large storage reservoir.

BROOKLYN, N. Y.—A contract has been awarded to Joseph Edwards & Co. to supply 25,000,000 gallons daily for a year for $175,000, and new bids will be asked for permanent pumping stations.

CATTARAUGUS, N. Y.—Steps are being taken to secure new works to cost $15,000 to $20,000. F. S. Oaks, Pres. Comrs.

CORINTH, N. Y.—The Dunn Water Supply Co. has awarded the contract for constructing its plant to Flood & Sherrill, Sandy Hill.

DUNKIRK, N. Y.—The contract for a 5,000,000-gallon cross-compound crank and flywheel pumping engine has been awarded to the Snow Steam Pump Wks., Buffalo. The pump is guaranteed to give a duty of 110,000,000.

HAMMONDSPORT, N. Y.—Bids are asked until Sept. 14 for constructing works, including 22,600 ft. of 8 to 2-in. pipe, 23 gate valves, 45 hydrants and reservoir; estimated cost, $20,010. G. H. Wheeler, Pres. Comrs., writes us that the citizens have voted to put in the works and that it is intended to have the construction commenced as soon as possible. L. H. Brown, Secy.

MORRISVILLE, N. Y.—The citizens have voted in favor of works estimated to cost $15,000, and the Stanwix Engineering Co., Rome, has been engaged to make the survey.

NEW YORK, N. Y.—Bids are asked by the department of public works until Sept. 18 for laying mains in 12 streets; also for furnishing and laying mains from new high service station to the tower and connecting mains at reservoirs at high bridge.

PAWLING, N. Y.—It is reported that works may be put in.

RED CREEK, N. Y.—The business men are reported as about to put in works, including a reservoir.

RICHMONDVILLE, N. Y.—The contract for works has been awarded to John Morrell, at $19,695.

WARSAW, N. Y.—J. N. Whitham, Engr., has reported that works, including pumping station, reservoir and main in every street, would cost less than $50,000.

ARLINGTON, N. J.—Geo. F. Woolston has submitted a proposition to furnish an artesian supply, in connection with the electric light plant.

BELLEVILLE, N. J.—Henry Dowd & Son, Orange, have been awarded a contract for several miles of extension.

DUNELLEN, N. J.—There is talk of works with a reservoir 1¼ miles distant.

BEAVER FALLS, PA.—The council has voted to build new works, including a filter plant, at a cost of about $125,000.

BELLE VERNON, PA.—S. F. Jones, Pres. Belle Vernon Water Co., writes us that the proposed works will require 7,000 ft. of 6-in. pipe, 700 ft. of 4-in., etc.; supply to be pumped from river; no contracts awarded or engineer employed.

CHRISTIANA, PA.—Kay & Coon, Bellwood, Pa., have secured the contract for constructing the plant of the Christiana Gravity Water Co. There will be about four miles of pipeline. The bids will be published in a later issue. Engr., Allan A. Herr, Lancaster.

DOWNINGTON, PA.—Thos. Holliday, Secy. Council, writes us that specifications have been completed for works and favorable bids received for the 16,000 ft. of 10 to 4-in. pipe which will be required.

LIVERPOOL, PA.—It is stated that works will be put in.

MACUNGIE, PA.—Chas. Weirbach, Allentown, has completed surveys for the new works, according to reports.

MILLERSTOWN, PA.—The question of works is being considered.

NEWVILLE, PA.—The citizens are reported as agitating the question.

PITTSBURG, PA.—Bids are asked until Sept. 8 for taking out one or more Lowry pumping engines and replacing the same with two or more vertical cross-compound condensing high duty pumping engines; also for furnishing and laying 1,300 ft. of 50-in. riveted steel rising main; also 48 and 36-in. cast iron pipe connections; also 100 gate boxes. E. M. Bigelow, Dir. Dept. Pub. Wks.

QUARRYVILLE, PA.—Kay & Coon, Bellwood, who built the works, have been awarded a contract for about a mile of extensions.

GRAFTON, W. VA.—The Snow Steam Pump Wks., Buffalo, has received the contract for a 2,000,000-gallon compound pumping engine for the new works.

WINSTON, N. C.—The citizens have voted in favor of the $100,000 loan, recently noted, for purchasing and improving the works. About $44,000 of this will be spent for a reservoir or stand-pipe, 1,500,000-gallon pumping engine, extensions, etc. Cy. Engr., J. O. Magruder.

CUTHBERT, GA.—The citizens have voted in favor of works and an electric light plant; estimated cost, $50,000.

OXFORD, MISS.—Ed. O. Davidson, Cy. Secy., writes us that surveys have been made and that probably $20,000 in bonds will soon be voted for works; population, 3,000.

THIBODEAUX, LA.—Bids are asked by the city until Sept. 12 for the construction of works.

PARIS, TENN.—Bids are asked until Sept. 10 for the construction of works and an electric light plant. H. Mayne, Cy. Recdr.

ASHTABULA, O.—Benj. A. May has been appointed receiver of the Ashtabula Water & Light Co.

BRADNER, O.—J. E. Ladd, Clk., writes us that the village has contracted with John Hosey, Bradner, to erect an 800-bbl. tank on a trestle, and that a steam pump to fill the tank will be purchased this month.

CELINA, O.—The citizens have voted to issue $50,000 in bonds for works.

LOUISVILLE, O.—It is stated that works will probably be completed this fall.

WELLINGTON, O.—An election will be held Sept. 22 to vote on issuing $35,000 in bonds for works.

DECATUR, IND.—Bids are asked until Sept. 18 for the construction of works, as stated in our advertising columns. Albert Brittson, Cy. Clk.

CHESANING, MICH.—E. T. Long writes us that the commission will award contracts this month for works to cost $14,500 and an electric plant to cost $5,500; water supply from wells.

HARROW, MICH.—Owing to a $30,000 fire last month, it is stated that works will probably be put in, at a cost of $4,000.

FORRESTON, ILL.—H. Dejough, Clk., writes us that the contract for tower and mains has been awarded to the U. S. Engine & Pump Co., at $6,454. The bids for works were as follows:

Fairbanks, Morse & Co., Chicago	$11,000
U. S. Engine & Pump Co., Batavia, Ill.	10,318
W. C. Burke, Freeport, Ill.	11,594

MOLINE, ILL.—T. D. Wheelock, Ch. Engr., writes us that the contracts for laying about 19,000 ft. of 10 to 6-in. extensions has been awarded to E. C. Blake, Dubuque, Ia., at $11,700.

NOKOMIS, ILL.—Geo. Schoper, Cy. Clk., writes us that a committee has been appointed to secure plans for works estimated to cost $15,000, but no definite system has been decided on. A satisfactory supply has been secured.

TURNER, ILL.—C. D. Clark writes us that a petition has been circulated asking the council to submit the question of works to a vote; population, 2,000.

AMERY, WIS.—M. A. Frissell writes us that works are nearly completed by Fairbanks, Morse & Co.

GRANTSBURG, WIS.—Bids are asked for furnishing plans and specifications for works; 6,000 ft. of mains, steam pump, 15 hydrants and 1,000-bbl. tank. A. A. Anderson, Village Clk.

OSHKOSH, WIS.—The mayor has appointed a committee to investigate the advisability of constructing new works, the present plant being owned by a private company.

BANCROFT, IA.—The citizens have voted in favor of works.

CLARKSVILLE, IA.—Geo. Ilgenfret, Town Clk., writes us that an election was held Aug. 30 to vote on an issue of $6,500 in bonds for a 90-ft. steel tower, 2,000-bbl. tank, gas engine, 5,000 to 6,000 ft. of 8 to 4-in. mains, 11 hydrants and engine house; plans prepared by the U. S. Wind Engine & Pump Co., Batavia, Ill.

DEXTER, IA.—Chas. C. Pugh, Mayor, writes us that an election will probably be held soon to vote on an issue of bonds for $7,500 for works; population, 850.

EAGLE GROVE, IA.—An election was held Aug. 30 to vote on an issue of bonds for $10,000 for works.

MINNEAPOLIS, MINN.—The council has voted to lay mains in about 55 streets.

CEDAR RAPIDS, NEB.—The contract for constructing works has been awarded to the U. S. Wind Engine & Pump Co., Batavia, Ill., at $9,000. The work will include a 76,000-gallon brick reservoir, 45,000-gallon power pump and wire rope transmission machinery, two 6-in. tube wells, pumphouse, 10,800 ft. of cast iron pipe, 10 hydrants and 6 valves. Some of the bids will be published in a later issue. Engr., G. H. Ellsworth, Fullerton, Neb.

LYONS, NEB.—The citizens have voted to issue $11,000 in bonds for works.

NEWCASTLE, NEB.—There is talk of putting in works.

OREGON, MO.—It is stated that a company is taking steps to put in works.

ERIE, COLO.—The citizens have voted to put in works to cost about $20,000. A previous election was declared illegal.

COTTAGE GROVE, ORE.—The contract for works at East Cottage Grove has been awarded to H. Orchard, Portland.

NEWBERG, ORE.—The citizens are reported to have voted $15,000 for works.

CRESCENT CITY, CAL.—The French Hill Water & Mining Co. has been incorporated with a capital stock of $50,000, of which $30,000 is subscribed, by Horace Gasquet, Gasquet; Wm. H. Hamilton and L. F. Cooper, Crescent City, and others.

SAN LUIS OBISPO, CAL.—C. F. Sammann, Cy. Clk., writes us that this city intends to construct works and that a committee has been appointed to engage an engineer to make plans; population, 4,000.

SPRINGVILLE, IA.—Bids will be opened soon for constructing works, including a 1,700-bbl. tank, 6-in. main, 7 hydrants, etc.; supply from artesian wells. A. L. Flude, Secy. W. W. Co.

BALLARD, WASH.—E. O. Marsh, Cy. Clk., writes us that an election will be held Sept. 10 to vote on an issue of $50,000 in bonds for works and an electric light plant; water supply from artesian well. Engr., S. K. Smith.

IRRIGATION.

SAN ANTONIO, TEX.—A press report from this city dated Aug. 30 states as follows: A company has been organized here and the water right filed for the construction of extensive canals and the irrigation of 10,000 acres of land in this county, immediately south of this city. The water will be obtained from the San Antonio River. Several delegates from Southwest Texas have left for Denver to attend the annual convention of the National Irrigation Congress. They will all advocate the appointment by Congress of a commission to treat with the Mexican government with a view of securing an amendment of the treaty so that dams can be constructed at different points along the Rio Grande River and the water of that stream used for irrigating the rich valley lands which are now arid. President Diaz has written one of the Texas delegates that he is in favor of the proposed amendment of the treaty.

NEW COMPANIES.—Columbus Power & Irrigation Co., Lincoln, Neb.; $150,000; Leander Gerrard, Chas. W. Pearsall, A. Anderson, Albert Stenger, G. W. Phillips, Adolph Jaeggi, A. G. Arnold, W. A. McAllister, O. T. Roen, Leopold Jaeggi and John H. Kersenbrock.

SEWERS.

LEICESTER, MASS.—The citizens have voted to accept the plans for a system and to borrow $4,000 to acquire land and construct an outlet sewer.

BUFFALO, N. Y.—Bids are asked until Sept. 12 for constructing 15 to 10-in. pipe sewers in three streets. R. G. Parsons, Secy. Dept. Pub. Wks.

CHARLOTTE, N. Y.—Plans for a system have been prepared by S. B. Kay, Bellwood, Pa., and bids will soon be asked for the construction.

NEW ROCHELLE, N. Y.—Bids are asked until Sept. 8 for constructing a brick building 28 × 38 ft. for sewage disposal works and for constructing 76 ft. of 18-in. outlet sewer. Engr., J. K. Wilkes.

NEW YORK, N. Y.—Bids are asked by the department of public works until Sept. 18 for constructing sewers in seven streets.

ROCHESTER, N. Y.—The East Side trunk sewer commission is discussing a plan for an overflow sewer in Griffith St. to be two miles in length and estimated to cost about $50,000.

TROY, N. Y.—Bids are asked until Sept. 11 for constructing a 40 × 26⅝-in. sewer in Jackson St. E. O. Ross, Secy. Contracting Bd.

PERTH AMBOY, N. J.—It is proposed to construct an 18 to 12-in. pipe sewer in East Ave.

UNION, N. J.—Bids are asked until Sept. 10 for constructing lateral sewers. Louis Formon, Town Clk.

WILMINGTON, DEL.—Bids are asked until Sept. 11 for constructing 1,086 ft. of 66 to 30-in. brick sewers and 2,544 ft. of 18 to 10-in. pipe sewers, as stated in our advertising columns. Engr., T. C. Hatton.

CHARLOTTESVILLE, VA.—The lowest bid for constructing the sewers recently advertised was that of Luck & Vaughan(Roanoke, at $45,621.

JACKSONVILLE, FLA.—Col. G. E. Waring, Jr., Newport, R. I., has been engaged to prepare plans and specifications for a system as recommended by him in his report to the board of public works.

TALLAHASSEE, FLA.—This city is discussing the question of a system. Col. G. E. Waring has been engaged as consulting engineer.

MARIETTA, O.—The following bids have been received by the council for the construction of sewers:

Z. T. Darrow, Findlay, O.	$14,414
W. J. Berry, Dillie's Bottom, O.	16,562
Walker & Robinson, Troy, O.	17,492
Charles Rosser, Bellaire,, O.	18,088
T. J. Stringer, Portland, O.	18,672
Stevenson & Finane Port Huron	19,019
Neal & Summers, Nelsonville, Mich.	19,044
Curry & Savage, Parkersburg, W. Va.	21,000
Ulrich, Nissley & Williams, Springfield, O.	21,217
W. W. Cook, Jamestown, N. Y.	21,703
E. A. Freshwater, Penrita, W. Va.	22,244
Curran & Maloney, Bellaire, O.	22,359
J. T. Hart, Marietta, O.	22,682
Jerry Hastings, Newport, Ky.	22,785
Caleb & Couture, Bridgeport, O.	23,034
Geo. F. Eagan, Pittsburg, Pa.	23,143
L. Cramer & Son, Parkersburg, W. Va.	23,598
Henry W. Anson, Akron, O.	23,642
Jas. L. McLane, Newport, Ky.	24,784
P. H. Kelley & Son, Portsmouth, O.	25,230
W. H. Logan & Co., Uhrichville, O.	25,287
Louis Mayer, Lancaster, W. Va.	27,202
Thos. J. Steers, Parkersburg, W. Va.	27,900
Wilson & Strack, Cincinnati, O.	28,501

L. Mueller, Cy. Clk., informs us that the contract has been informally awarded to Z. T. Darrow.

SANDUSKY, O.—Bids are asked until Sept. 27 for the purchase of $12,000 of 5% sewer bonds. A. W. Miller, Cy. Clk.

TIFFIN, O.—The clerk has been directed to advertise for bids for constructing several sewers.

HUNTINGTON, IND.—Bids are asked until Sept. 11 for constructing a 45 to 24-in. brick sewer. Wm. Schwartz, Cy. Clk.

ANN ARBOR, MICH.—The council has passed resolutions to construct sewers in Washington St. and to complete sewers in Ward 5.——The committee has recommended that the main sewer be reconstructed.

JACKSON, MICH.—It is reported that the committee will recommend that bonds for $70,000 be issued for constructing sewers, iron bridges, extending the water system and for paving.

LOCKPORT, ILL.—Bids are asked until Sept. 10 for constructing sewers. F. H. Reed, Cy. Clk.

MINNEAPOLIS, MINN.—The council has passed ordinances for constructing 54 to 12-in. brick sewers in 20 streets, and 12-in. pipe sewers in six streets.

ST. LOUIS, MO.—The lowest bids received last week for constructing sewers were reported as follows: Rocky Branch sewer, G. G. Prendergast, $15,015; Pine St. sewer, Hussey & Seese, $14,256; Rock Springs sewer, Hussey & Seese, $11,534; Southern sewer, G. P. Prendergast, $14,197; Fillmore St. sewer, Penney & Meyers, $12,898. Sewers in Ferry St. sewer district No. 23, Kelly & Morran, $893; Elliott Ave. sewer district No. 45, R. Sheehan, $1,151; northwestern sewer district No. 29, J. Gilbane, $584; Accomac St. sewer district No. 5, Skrainka Construction Co., $2,187; Minnesota Ave. sewer district No. 5, Skrainka Construction Co., $3,608; Warne Ave. sewer district No. 5, Robert Sheehan, $3,055. Some of the itemized bids will be published in a later issue.

WACO, TEX.—The city engineer has recommended the construction of sewers; estimated cost, about $12,000.

LINDSAY, ONT.—The council has passed an ordinance for an election to vote on the question of issuing $25,000 in bonds for a system.

LOS ANGELES, CAL.—Plans are being made for a sewer to connect the conduit of the South Side Irrigation Co. with the San Pedro St. sewer.

STREETS.

NEW YORK, N. Y.—Bids are asked by the department of parks until Sept. 12 for furnishing 3,300 bbls. Portland cement, 2,700 cu. yds. broken stone, and 900 cu. yds. of sand.

WAKEFIELD, N. Y.—The citizens have voted to spend $20,000 for improving the streets.

PITTSTON, PA.—Bids are asked until Sept. 10 for 3,400 sq. yds. of paving in Main and Water Sts. J. E. Dempsey, Borough Secy.——Plans have been completed for paving Main St. with brick or asphalt, at an estimated cost of $87,000.

WILKINSBURG, PA.—The residents of Kelly Ave. will petition the council to pave that street.

CLEVES, O.—The council is discussing the question of constructing sidewalks; estimated cost, $10,000 to $50,000.

COLUMBUS, O.—The council is asking for bids for paving a portion of North High St.; estimated cost, with asphalt $66,408, stone blocks $110,613, or with Hayden blocks $67,881.——Ordinances have been passed to issue $125,000 in bonds for paving two streets.

FINDLAY, O.—Bids are asked until Sept. 11 for macadamizing Santee Ave. S. P. De Wolfe, Cy. Clk.

SABINA, O.—The council is discussing the grading and curbing of the streets, and construction of sidewalks.

INDIANAPOLIS, IND.—The following bids have been received by the board of public works for paving Meridian St., from South to McCarty Sts., with asphalt: Western Paving & Supply Co., $6.63 to $6.87 per lin. ft.; Indiana Bermudez Asphalt Co., $6.98 to $7.24; Warren-Scharf Asphalt Paving Co., $7.78 to $8.08; Trinidad Asphalt Refining Co., New York, Pres. Hugo Reid, $5.61 to $5.71.

KOKOMO, IND.—The council has passed resolutions for paving over a mile on four streets with brick.

SOUTH BEND, IND.—Bids are asked until Sept. 24 for paving with brick. L. A. Hull, Cy. Clk.

DECATUR, ILL.—The council has passed ordinances for paving to cost about $20,000.

QUINCY, ILL.—The council has rejected all the bids for brick paving, and will purchase the materials and do the work by day labor or sub-contracts. The bids ranged from $1.10 to $1.30 per sq. yd.

HOT SPRINGS, ARK.—The chamber of commerce has been discussing the necessity of having Garrison Ave. and Central Ave. paved with brick.

HOUSTON, TEX.—Bids are asked until Sept. 17 for paving with asphalt, brick or stone. J. T. Browne, Mayor.

ELECTRIC LIGHT AND POWER.

JAMESTOWN, N. Y.—The board of public works has been directed to advertise for new bids for the proposed extension to the electric light plant.——The Jamestown Electric Light & Power Co. has offered to sell its plant to the city for $132,500.

KINGSTON, N. Y.—Bids are asked until Sept. 14 for an electric light plant, as stated in our advertising columns. Augustus Stepmoes, Cy. Clk.

MILLERSTOWN, PA.—It is reported that this place is to have an electric light plant.

PARIS, TENN.—Bids are asked until Sept. 10 for the erection of an electric light plant. H. Mayne, Recdr.

DAYTON, O.—An appropriation of $11,500 has been made for an electric light plant at the insane asylum.

NEW HARMONY, IND.—A contract has been awarded for street lighting at $1,000 a year for 12 arc lights and $85 for each additional light.

OTSEGO, MICH.—It is reported that an electric light plant will be put in.

STILLWATER, MINN.—Bids are asked by the city clerk until Sept. 18 for lighting the city by electricity.

OMAHA, NEB.—The council received bids Aug. 28 for lighting the city by electricity. The Citizens' Electric Light & Power Co. offered to furnish lights for $135 each per year, but bids were received a short time ago at $87.50, $95 and $111.50 per year and the council is now discussing the advisability of constructing a municipal plant.

ST. CHARLES, MO.—An election was held Aug. 28 to vote on the question of granting a franchise to an electric light company.

SEATTLE, WASH.—Bids are asked until Sept. 10 for electric street lighting for one year. G. F. Meacham, Secy. Bd. Pub. Wks.

WATERFORD, ONT.—Bids are asked until Sept. 10 for the purchase of the plant, stock and real estate of the Reliance Electric Mfg. Co., valued at $34,764. C. S. Scott, 28 James St., Hamilton.

NEW COMPANIES.—Caldwell Electric Light & Water Co., Caldwell, O.; $10,000.——Montgomery Electric Light & Power Co., Montgomery, Ill.; $10,000.——Citizens' Electric Co., Middletown, O.; $20,000; Pres., Thomas Cooper, Columbia; Secy., W. H. Drayer, Middletown.——Acme Electric Light & Power Co., North East, Pa.; $15,000; Treas., F. O. Davis.——Phoenix Electric Light Co., McKee Rocks, Pa.; $5,000; Treas., H. C. Johnson, Pittsburg.——Orville Gas, Electric Light & Power Co., Orville, Cal; $32,000; Max Marks, F. H. Gray, C. H. Schiveley, J. C. Osgood, W. E. Duncan, Jr.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

ROCK EXCAVATION.—Burlington, Vt.—Bids are asked until Oct. 5 for rock excavation in Otter Creek, Vt., as stated in our advertising columns. Capt. Smith S. Leach, U. S. Engr.

ROUND HOUSE.—Mattoon, Ill.—The contract for a $12,000 round house at this place has been awarded by the Cleveland, Cincinnati, Chicago & St. Louis Ry. Co. to D. Stewart & Co., St. Louis.

DRAINAGE CANAL.—Chicago, Ill.—Bids are asked until Sept. 12 for completing the work on section E of the main drainage canal, as stated in our advertising columns. Thos. F. Judge, Clk.

REPAIRS TO BREAKWATER.—Burlington, Vt.—Bids are asked until Oct. 5 for repairs to the Burlington breakwater, as stated in our advertising columns. Capt. Smith S. Leach, U. S. Engr.

LIGHT STATION.—Baltimore, Md.—Bids are asked until Sept. 26 for furnishing material and constructing the Solomons Lump light station, Maryland; separate bids to be received for the metal work. Capt. Eric Bergland, U. S. Lighthouse Engr.

CRIB REPAIRS, ETC.—Washington, D. C.—Bids are asked until Sept. 25 for repairs of tramway cribs, ice fenders, bridge, stone filling, etc., at U. S. naval magazine, Fort Mifflin, Pa., near Philadelphia. W. T. Sampson, Chief of Ordnance, Navy Dept.

GARBAGE CREMATORY.—Dayton, O.—Dr. A. H. Iddings, Health Officer, has stated that a crematory is a necessity in this city, and that one should be purchased which will destroy night soil and all garbage that cannot be disposed of through the sewers.

IRON WORK.—Charleston, W. Va.—Bids are asked until Sept. 27 for iron work for movable dams on the Great Kanawha River. The work will require about 635,000 lbs. of wrought iron and 337,000 lbs. of cast iron. Col. Wm. P. Craighill, U. S. Engr. Office.

PLUMBING, ETC.—Washington, D. C.—Bids are asked until Sept. 20 for the plumbing, gas piping and electric wire conduits for the U. S. public building at Newark, N. J., as stated in our advertising columns. Jeremiah O'Rourke, Supervising Arch., Treasury Dept.

RUBBLE STONE.—Boston, Mass.—Bids are asked until Oct. 4 for delivering rubblestone in the south jetty at Newburyport Harbor, Mass.; also in breakwater at Gloucester Harbor, Mass., as stated in our advertising columns. Lieut.-Col. S. M. Mansfield, U. S. Engr.

BRICK AND TERRA COTTA WORK.—Washington, D. C.—Bids are asked until Sept. 17 for the brick and terra-cotta floor arches, terra-cotta column covering, wall furring, etc., for the U. S. public building at De-

troit, Mich. Jeremiah O'Rourke, Supervising Arch., Treasury Dept.

CANAL.—Chicago, Ill.—Bids are asked until Sept. 20 for constructing four miles of the eastern section of the Illinois & Mississippi Canal, between mile 4 and mile 8; also for excavating the lock pits and constructing the foundations for three locks. Capt. W. L. Marshall, U. S. Engr. Office.

WHARVES, ETC.—West Norfolk, Va.—W. B. Causey, Engr. Maintenance of Way, Atlantic & Danville Ry., Portsmouth, writes that the contract for the construction of wharves and warehouses and for dredging at this place has been awarded to Rutherford & Brown, New York. The other bidders were: I. Eugene White, New York; Lewis P. Evans, Philadelphia; Sanford & Brooks, Baltimore; L. B. McCabe & Bro., Baltimore, and H. E. Culpepper, Portsmouth, Va.

BUILDINGS.—Washington, D. C.—Bids are asked until Sept. 21 for constructing the U. S. public building at Roanoke, Va. Jeremiah O'Rourke, Supervising Arch., Treasury Dept.

Helena, Mont.—Bids are asked until Sept. 19 for constructing buildings at Fort Harrison. Capt. Geo. S. Hoyt, Asst. Q. M., U. S. A.

Plattsburg, N. Y.—Bids are asked until Sept. 27 for constructing buildings at Plattsburg barracks, N. Y. Capt. Geo. E. Pond, Asst. Q. M., U. S. A.

DREDGING.—Boston, Mass.—Bids are asked until Oct 4 for dredging in Powou River, Mass., as stated in our advertising columns. Lieut.-Col. S. M. Mansfield, U. S. Engr.

Washington, D. C.—Bids are asked until Oct. 4 for dredging at Nomini and Lower Machodoc creeks, Va., as stated in our advertising columns. Maj. Chas. E. L. B. Davis, U. S. Engr.

Burlington, Vt.—Bids are asked until Oct. 5 for dredging in Ogdensburg Harbor and Great Chazy River, N. Y., as stated in our advertising columns. Capt. Smith S. Leach, U. S. Engr.

DISINFECTING PLANTS.—Washington, D. C.—The following bids have been received by the supervising architect for disinfecting plants at U. S. quarantine stations:

At San Diego, Cal.:

Coronado Foundry & Machine Co., Coronada, Cal.	$7,985
Standard Iron Wks., San Diego, Cal.	8,033
Sterne Bros., San Diego, Cal.	8,125

At Port Townsend, Wash.:

Nickolls & Crother, Tacoma, Wash.	$5,765
Jas. M. Lively, Port Townsend, Wash.	8,200
Puget Sound Engin'g Wks., Port Townsend, Wash.	8,176

DREDGING STEAMER.—Wilmington, N. C.—The following bids were received by Maj. W. S. Stanton, U. S. Engr. Office, for building a dredging steamer (1) being for a steamer equipped with Edward dredging machinery, (2) with Howell's, and (3) without machinery:

	1	2	3
Bath Iron Wks., Bath, Me.	$71,500	$78,100	$58,900
W.E. Woodall & Co., Baltimore	58,650	65,800	45,560
Atlantic Wks., E. Boston, Mass.	56,170	64,536	46,200
John H. Dialogue & Son, Camden, N. J.	.....	.....	43,550
Pusey & Jones Co., Wilmington, Del	61,500	.....	51,000
Chas. Hillman Ship & Engine Bldg. Co., Philadelphia	*53,000	58,000	42,000
H. Ramsey, Perth Amboy, N.J.	54,900	.....	47,200

* Accepted.

LUMBER.—Brooklyn, N. Y.—Bids are asked until Sept. 10 for a supply of 500,000 ft. B. M., of lumber. C. C. Martin, Ch. Engr., New York & Brooklyn Bridge.

CONDENSED LIST OF CONTRACTS PENDING WITH DATE OF OPENING BIDS.

Bids to be opened.	Work.	Place.	See Eng. News.
Sept. 7.	Iron and copper w'k,	Washington, D.C.	Aug. 23
Sept. 7.	Stone paving,	New York, N. Y.	Aug. 23
Sept. 7.	Bonds ($14,362),	Norwood, O.	Aug. 16
Sept. 7.	Intake pier,	Tonawanda, N. Y.	Aug. 23
Sept. 7.	Canal work,	Albany, N. Y.	Aug. 30
Sept. 7.	Cobblestone paving,	Brooklyn, N. Y.	Aug. 30
Sept. 7.	Highway,	Duluth, Minn.	Aug. 30
Sept. 7.	Grading, etc.,	Duluth, Minn.	Aug. 30
Sept. 8.	Asphalt paving,	Cincinnati, O.	Aug. 16
Sept. 8.	Electric l't. plants,	Washington, D. C.	Aug. 30
Sept. 8.	Fire alarm equipment,	Boston, Mass.	Aug. 30
Sept. 8.	Sewage disp'l bldg.,	New Rochelle, N.Y.	Sept. 6
Sept. 8.	Pumping engines,	Pittsburg, Pa.	Sept. 6
Sept. 8.	Steel water pipe, etc.,	Pittsburg, Pa.	Sept. 6
Sept. 10.	City hall and market,	Jacksonville, Fla.	Aug. 16
Sept. 10.	Bridges,	Helena, Mont.	Aug. 16
Sept. 10.	Brick sidewalks,	Springfield, O.	Aug. 23
Sept. 10.	Sidewalk bonds ($5,000),	Carthage, O.	Aug. 23
Sept. 10.	Bridge,	Toledo, O.	Aug. 16
Sept. 10.	Dynamos and engines,	Washington, D.C.	Aug. 30
Sept. 10.	Water-works system,	Alexandria, La.	Aug. 30
Sept. 10.	Electric light plant,	Alexandria, La.	Aug. 30
Sept. 10.	Pipe sewers,	South Bend, Ind.	Aug. 30
Sept. 10.	Sewers,	Union, N. J.	Sept. 6
Sept. 10.	Paving (3,400 sq. yds.),	Pittston, Pa.	Sept. 6
Sept. 10.	Electric light plant,	Paris, Tenn.	Sept. 6
Sept. 10.	Water-works system,	Paris, Tenn.	Sept. 6
Sept. 10.	Sewers,	Lockport, Ill.	Sept. 6
Sept. 10.	Iron bridge,	Fairbury, Neb.	Sept. 6
Sept. 10.	Electric lighting,	Seattle, Wash.	Sept. 6
Sept. 10.	Purchase elect. l't plnt,	Waterford, Ont.	Sept. 6
Sept. 10.	Lumber (500,000 ft.),	Brooklyn, N. Y.	Sept. 6
Sept. 11.	Granite paving,	New York, N. Y.	Aug. 30
Sept. 11.	Light station,	New Orleans, La.	Aug. 16
	Advertised, Eng. News, Aug. 16 to Sept. 6.		
Sept. 11.	Metal work,	New Orleans, La.	Aug. 16
	Advertised, Eng. News, Aug. 16 to Sept. 6.		
Sept. 11.	Sewers,	Troy, N. Y.	Sept. 6
Sept. 11.	Pipe sewer,	Wilmington, Del.	Sept. 6
	Advertised, Eng. News, Sept. 6.		
Sept. 11.	Brick sewers	Wilmington, Del.	Sept. 6
	Advertised, Eng. News, Sept. 6.		
Sept. 11.	Macadamizing,	Findlay, O.	Sept. 6
Sept. 11.	Brick sewers,	Huntington, Ind.	Sept. 6
Sept. 12.	Brick paving,	Cleveland, O.	Aug. 16
Sept. 12.	Bonds ($13,000),	Canton, O.	Aug. 23
Sept. 12.	Pipe sewers,	Buffalo, N. Y.	Sept. 6
Sept. 12.	Stone (2,700 cu. yds.),	New York	Sept. 6
Sept. 12.	Cement (3,300 bbls.),	New York	Sept. 6
Sept. 12.	Water-works system,	Thibodeaux, La.	Sept. 6
Sept. 12.	Drainage canal work,	Chicago, Ill.	Sept. 6
	Advertised, Eng. News, Sept. 6.		
Sept. 13.	Brick paving,	Alliance, O.	Aug. 30
Sept. 13.	Rock, etc., for paving,	Jacksonville, Fla.	Aug. 30
Sept. 13.	Buildings, etc.,	Burlington, Vt.	Aug. 23
Sept. 14.	Pipe sewers,	Charleston, S. C.	Aug. 30
	Advertised, Eng. News, Aug. 30 and Sept. 6.		
Sept. 14.	Electric light plant,	Lancaster, Pa.	Aug. 16
Sept. 14.	W-wks system,	Hammondsport, N.Y.	Sept. 6
Sept. 14.	Electric light plant,	Kingston, N. Y.	Sept. 6
	Advertised, Eng. News, Sept. 6.		
Sept. 15.	Asphalt paving,	Cincinnati, O.	Aug. 30
Sept. 15.	Water bonds ($100,000),	Detroit, Mich.	Aug. 30
Sept. 15.	Electric light plants,	Toronto, Ont.	Aug. 30
	Advertised, Eng. News, Aug. 2 to 16.		
Sept. 15.	Water-works bonds,	Avoca, Minn.	Aug. 30
Sept. 15.	Water bonds ($100,000),	Detroit, Mich.	Aug. 16
Sept. 15.	Garbage crematory,	Ft. Wadsworth, N.Y.	Aug. 23
Sept. 17.	Electric lighting,	Hempstead, N. Y.	Aug. 30
Sept. 17.	Pipe sewers (15,093 ft.),	Scottdale, Pa.	Aug. 30
	Advertised, Eng. News, Aug. 30 and Sept. 6.		
Sept. 17.	Sidewalks (13 contracts),	Houston, Tex.	Aug. 30
Sept. 17.	Iron hoist bridge,	Dayton, O.	Aug. 23
Sept. 17.	Brick work, etc.,	Washington, D. C.	Sept. 6
Sept. 17.	Paving,	Houston, Tex.	Sept. 6
Sept. 18.	Bldg superstructure,	Washington, D.C.	Aug. 30
Sept. 18.	New channel,	Ottawa, Ont.	Aug. 30
Sept. 18.	Water-works system,	Guttenberg, Ia.	Aug. 23
	Advertised, Eng. News, Aug. 23 to Sept. 6.		
Sept. 18.	Laying water mains,	New York	Sept. 6
Sept. 18.	Sewers,	New York	Sept. 6
Sept. 18.	Stone arch bridge,	Sandusky, O.	Sept. 6
Sept. 18.	Water-wks. system,	Decatur, Ind.	Sept. 6
	Advertised, Eng. News, Sept. 6 and 13.		
Sept. 18.	Electric lighting,	Stillwater, Minn.	Sept. 6
Sept. 19.	Buildings,	Helena, Mont.	Sept. 6
Sept. 19.	Bridge,	Baltimore, Md.	Sept. 6
Sept. 20.	Police station,	Cleveland, O.	Aug. 30
Sept. 20.	Fire engines,	Cleveland, O.	Aug. 30
Sept. 20.	Plumbing, etc.,	Washington, D. C.	Sept. 6
	Advertised, Eng. News, Sept. 6 and 13.		
Sept. 20.	Canal (4 miles),	Chicago, Ill.	Sept 6
Sept. 21.	Jail,	Ortonville, Minn.	Aug. 30
Sept. 21.	Public buildings,	Washington, D. C.	Sept. 6
Sept. 22.	Brick paving,	Cincinnati, O.	Aug. 30
Sept. 22.	Rock removal,	Detroit, Mich.	Aug. 30
Sept. 22.	Dams, etc.,	Rock Island, Ill.	Aug. 30
	Advertised, Eng. News, Aug. 30 to Sept. 20.		
Sept. 24.	Brick paving,	South Bend, Ind.	Sept. 6
Sept. 25.	Stone,	Nashville, Tenn.	Aug. 30
	Advertised, Eng. News, Aug. 30 to Sept. 20.		
Sept. 25.	Crib repairs, etc.,	Washington, D. C.	Sept. 6
Sept. 26.	Sewers,	Sandusky, O.	Aug. 30
Sept. 26.	Metal work,	Baltimore, Md.	Sept. 6
	Advertised, Eng. News, Sept. 6 and 13.		
Sept. 26.	Light station,	Baltimore, Md.	Sept. 6
	Advertised, Eng. News, Sept. 6 and 13.		
Sept. 27.	Buildings,	Plattsburgh, N. Y.	Sept. 6
Sept. 27.	Iron work,	Charleston, W. Va.	Sept. 6
	Advertised, Eng. News, Sept. 6 to 20.		
Sept. 27.	Sewer bonds ($12,000),	Sandusky, O.	Sept. 6
Sept. 28.	Stone arch bridge,	Sandusky, O.	Aug. 30
Sept. 28.	Paving (10,174 sq.yds.),	Van Wert, O.	Aug. 30
	Advertised, Eng. News, Aug. 30 to Sept. 20.		
Sept. 29.	Bridges,	Indianapolis, Ind.	Aug. 23
Oct. 1.	Electric lighting,	Vicksburg, Miss.	Aug. 30
Oct. 2.	Electric lighting,	Jackson, Tenn.	Aug. 30
Oct. 2.	Water-works system,	Greenville, Miss.	Aug. 23
	Advertised, Eng. News, Aug. 23 to Sept. 13.		
Oct. 4.	Rubble stone (2 contracts),	Boston.	Sept. 6
	Advertised, Eng. News, Sept. 6 to 20.		
Oct. 4.	Dredging,	Boston, Mass.	Sept. 6
	Advertised, Eng. News, Sept. 6 to 20.		
Oct. 4.	Dredging,	Washington, D. C.	Sept. 6
	Advertised, Eng. News, Sept. 6 to 27.		
Oct. 5.	Breakwater repairs,	Burlington, Vt.	Sept. 6
	Advertised, Eng. News, Sept. 6 to 27.		
Oct. 5.	Dredging (2 contracts),	Burlington, Vt.	Sept. 6
	Advertised, Eng. News, Sept. 6 to 27.		
Oct. 5.	Rock excavation,	Burlington, Vt.	Sept. 6
	Advertised, Eng. News, Sept. 6 to 27.		
Oct. 19.	Jail cells, etc.,	Auburn, Cal.	Aug. 30
Oct. 31.	Drawbridges,	Chicago, Ill.	Sept. 6
	Advertised, Eng. News, Sept. 6.		
Oct. 31.	Bridge masonry,	Chicago, Ill.	Sept. 6
	Advertised, Eng. News, Sept. 6.		
No date.	Plans for w.-wks.,	Grantsburg, Wis.	Sent 6

CONTRACT PRICES.

BOILERS.—Chicago, Ill.—The following bids were received recently for the installation of 1,500-HP. boilers in the new municipal lighting plants:

Babcock & Wilcox	$28,160
Campbell & Zell	20,898
The Stirling Co.	20,412
Heine Safety Boiler Co. (awarded contract)	19,316
The Caldwell-Standard Boiler Co.	14,800

WATER-WORKS.—Estherville, Ia.—P. Canfield Barney, Engr., Chillicothe, Mo., writes us that the contract for water-works has been awarded to C. H. Hubbard, Sioux Falls, S. Dak. The contract for the entire plant, including electric light plant, was awarded at $15,378, some of the lowest bids being as follows: Pipe, $22.95 per ton of 2,000 lbs.; specials, 2½ cts. per lb.; stop boxes, $3.60 each; valves, 10-in., $22.10; 8-in., $16; 6-in., $9.65; hydrants, 6-in., $21.35; 4-in., $21.35; pipelaying, 10-in., 18 cts. per ft.; 8-in., 15 cts.; 6-in., 13½ cts.; 4-in., 12 cts.; 500,000-gallon pump, $464; two 48-in. × 16-ft. boilers, erected, $1,650; one 75-HP. Corliss engine, by Sioux City Iron Wks., $1,574.

BRIDGE.—Troy, O.—B. E. Furnes, Audr Miami County, writes us that the following bids were received Aug. 25 for furnishing the material and erecting a high truss iron bridge over the Great Miami River near Piqua, the bridge to consist of two spans with not less than eight panels each, about 150 ft. each in length, pin centers, with a clear roadway of 16 ft. in width, and a clear headway of 17 ft.; the bridge to be built to carry a rolling load of 100 lbs. per sq. ft.; flooring to be of 2½ in. white oak plank, 8 × 12 ins.; floor joist to be of 9 lines of 3 × 12 white oak; hub guards to be iron latticed 18 ins. deep; bidders submitted their own plans; price is given per foot, the second column being the price per foot additional for steel joist:

Rogers Iron Co., Springfield, O.	21.35	1.35
Indiana Bridge Co., Cincinnati, O.	23.50	1.30
Detroit Bridge & Iron Wks., Detroit, Mich.	22.80	2.05
Toledo Bridge Co., Toledo, O.	23.30	1.40
Brackette Bridge Co., Cincinnati, O.	23.30	1.33
Ohio Bridge Co., Toledo, O.	27.25	....
Iron Substructure Co., Columbus, O.	26.30	1.42
Buchanan Bridge Co., Bellefontaine, O.	22.00	1.50
Variety Iron Wks., Cleveland, O.	23.80	1.47
Wrought Iron & Bridge Co., Canton, O.	24.35	1.95
Youngstown Bridge Co., Youngstown, O.	25.00	1.50
Groton Bridge & Mfg. Co., Groton, N. Y.	24.00	....
Columbus Bridge Co., Columbus, O.	22.00	1.30
Canton Bridge Co., Canton, O.	24.97	incl'd
Jackson Bridge & Iron Wks., Jackson, Mich.	23.20	24.80
King Bridge & Iron Wks., Cleveland, O.	22.05	1.35

DRAINAGE.—Mallorytown, Ont.—B. J. Saunders, Cy. Engr., Brockville, writes us that the contract for the Jones' Creek drainage work, about 11 miles, has been awarded to Herman McGill, Dixon, Ont., at $6,400 lump sum for 32,000 cu. yds. of excavation, including cutting and removing timber, brush, etc.; $1.45 per cu. yd. additional for about 150 cu. yds. of rock; 75 cts. per cu. yd. additional for 150 cu. yds. of loose rock; and 18 cts. per cu. yd. to be deducted from lump sum in case of changes of alinement or grade of ditch so as to change estimated quantity of earth excavation. Wm. Garson, Brockville, bid $6,350, $3, $1 and 20 cts., respectively; Jas. R. Smythe, Mountain, Ont., $6,800, $1.40, 68 cts. and 19 cts.; Bowie, Hagerty & Warwick, Brockville, $7,600, $2.40, $1.35 and 21 cts.; and John Easton, Brockville, $9,920, $1.50, 65 cts. and 31 cts.

ENLARGING ISLAND.—New York, N. Y.—C. W. Adams, State Engr., Albany, writes us that the following bids were received by the commissioners of quarantine Aug. 24 for the improvement at Hoffman Island, recently advertised:

Bids Received for Enlarging Hoffman Island, New York Harbor.

	P. Sanford Ross.	F. & A. Walsh.	Boker Contracting Co.	Colin McLean.	Spearin & Preston.
Embankment, 104,800 cu. yds. per cu. yd.	$0.28	$0.25	$0.40	$0.25	$0.35
Excavation of old rip-rap, 1,800 cu yds. " " "	2.50	1.00	.70	1.00	1.00
Stone filling in cribs, 5,000 cu. yds. " " "	.83	.60	.75	.80	.75
Rip-rap stone, in place, 28,800 cu. yds. " " "	.83	.95	1.00	.85	.80
American Portland cem't concrete, 10 cu.yds " " "	7.00	6.00	10.00	7.00	10.00
Coursed ashlar, including coping, American Portland cement, 900 cu. yds. per cu. yd.	14.00	16.00	15.65	13.00	20.00
Coursed rubble, in American Portland cement, 2,350 cu. yds. per cu. yd.	5.75	8.00	6.10	6.50	10.00
Southern pine timber, 1,163,000 ft.B.M., per M.ft. B.M.	29.00	35.00	35.00	40.00	40.00
Wrought iron drift and wedge bolts, in work, 69,100 lbs., per lb.	.03½	.02	.04	.04	.02½
6-in. and 12-in. cast iron pipe, in work, 7½ tons, per gross ton	35.00	35.00	50.00	35.00	50.00
Spikes and nails, 1,000 lbs., per lb.	.03½	.02	.04	.03½	.03
Removing out-houses and platform on east side of island and resetting out-houses	500.00	200.00	100.00	350.00	500.00
Deduct materials furnished by State—Old rip-rap stone 2,000 cu. yds., at 75 cts.	$1,500				
Total	$123,523	$132,680	$146,734	$131,956	$154,522

CANAL LOCK PITS, ETC.—Chicago, Ill.—The lowest bids received by Capt. W. L. Marshall, U. S. Engr. Office, Aug. 27, for constructing the first four miles of the eastern section of the Illinois & Mississippi Canal and for excavating the lock pits and constructing the foundations for four locks were as follows: First mile, 101,367 cu. yds., Wm. Callahan, Omaha Neb., 9.95 cts. per cu. yd.; second mile, 90,324 cu. yds., Wm. Callahan, 7⅝ cts.; third mile, 87,313 cu. yds., Ed. Phelan, Omaha, Neb., 10 cts.; fourth mile, 150,004 cu. yds., Ed. Phelan, Omaha, and the Kimball & Cobb Stone Co., Chicago, each bid 9 cts.; lock pits and foundations, Mall & Doan, Aurora, Ill., lock No. 1, $10,404; lock No. 2, $11,159; lock No. 3, $9,849; lock No. 4, $10,135. There were 23 bidders and the itemized bids will probably be published next week.

ASPHALT PAVING.—Chicago, Ill.—The following bids were received for paving (1) Lexington Ave. and (2) Flournoy St., with asphalt:

Bidder.	1.	2.
A. Jaicks per sq. yd.	$2.54	$2.50
Western Paving & Supply Co. " " "	2.42	2.41
United States Paving Co. " " "	2.25	2.17
Barber Asphalt Co. " " "	2.57	2.55
Trinidad Asphalt Co. " " "	1.55	1.55
Bermudez Asphalt Co. " " "	2.02	2.02
Jas. A. W. Pine, New York. " " "	1.49	1.49

The complete bids of the two lowest bidders were as follows: Trinidad Asphalt Co. (lowest), paving, $1.55 per sq. yd.; curbing, 65 cts. per lin. ft.; filling, 27 cts. per cu. yd. J. A. W. Pine, $1.49, 70 cts. and 40 cts., respectively. The bids received for paving La Salle Ave. with Trinidad Lake asphalt were published in our issue of Aug. 22.

BRICK PAVING.—Huntingdon, Pa.—It is stated that Horace V. Johnston has been awarded a contract for street paving with Koontz brick, at 75 cts. per sq. yd.

Quincy, Ill.—Bids have been opened for paving in several streets with brick, the prices ranging from $1.11 to $1.30 per sq. yd. for the paving, and 39 to 43 cts. per lin. ft. for curbing. The council concluded that the work could be done for $1 to $1.08 per sq. yd. and has rejected all the bids.

Newark, O.—The bids for paving North Fourth St. with brick ranged from 75 cts. to $1.14 per sq. yd., according to brick; curbing, 30 to 38 cts. per lin. ft.

DRAINAGE CANAL.—Chicago, Ill.—The contract for constructing section 15 of the drainage canal has been awarded to Wright, Meysenburg, Sinclair & Carry, Chicago, at 19 cts. per cu. yd. for glacial drift, 50 cts. for solid rock, and $2.35 for retaining walls. The total bids were published last week.

SEWERS.—Philadelphia, Pa.—The following contracts for main sewers were awarded by James H. Windrim, Dir. Pub. Wks., Aug. 23: K. & D. Dooley, 51st and Wyalusing Ave.—Connections with intercepting sewer on Jefferson St. and Westview Ave., size, 4 ft.; length, 761 ft.; $7.95; connections with intercepting sewer on Upsal and Franklin Sts., size, 4 ft. 3 ins.; length, 1,347 ft.; $8.44. D. McMahon, E. Chelten Ave., Germantown—Connections with intercepting sewer on Germantown Ave. from Rex Ave. northward, size, 10 ins.; length, 278 ft.; $2.48. M. & J. B. McHugh, 259 S. 10th St.—Connections with intercepting sewer on Cresheim Ave., Germantown, to Crittenden St., size, 30 × 20 ins.; length, 2,323 ft.; $4.47; size, 27 × 18 ins.; length, 400 ft.; $4.15. Extension Lincoln Ave. intercepting sewer, north of Carpenter St., 4 ft. 9-in. conduit with 2-ft. brick sewer, length, 462 ft.; $6.50. John Bonhage, 2618 Huntingdon St.—Ontario St. Delaware River, to end of present contract near Myrtle St., size, 8 ft.; length, 1,818 ft.; $18.50. J. A. Mundy & Bro., 211 S. 9th St.—Section of Wingohocking intercepting sewer at Cayuga and B Sts., under Bustleton R. R., size, 19 ft. 6 ins.; length, 159 ft.; $53.00; size, 6 ft.; length, 159 ft.; $9.83. Jones & Wallace, Wissahickon—Connections with intercepting sewer, Manayunk, on Lauriston and Vicaris Sts., size, 2 ft. 6 ins. with 8-in. pipe; length, 405 ft.; $8.22; size, 15-in. pipe with 8-in.; length, 414 ft.; $7.07. Contracts were also awarded for about 12,000 lin. ft. of branch sewers in various sections of the city, amounting in all to about $38,000, sizes varying from 12-in. terra cotta pipe to 4-ft. × 2 ft. 8-in. egg shaped brick sewer.

METAL MARKET PRICES.

LEAD.—New York: 3.25 to 3.3 cts. Chicago: 3.13 to 3.2 cts. St. Louis: 3.02 to 3.15 cts.

NAILS.—Pittsburg: $1.05 for wire, and 90 cts. for cut at mill, in carload lots.

BARBED WIRE.—Pittsburg: galvanized, $2.05; plain, $1, for carload lots at mill.

FOUNDRY AND PIG IRON.—New York: $11 to $13. Pittsburg: $10.75 to $12. Chicago: $9.50 to $10.50.

TRACK MATERIAL.—New York: angle bars, 1.25 to 1.4 cts.; spikes, 1.5 to 1.7 cts.; track bolts, 2 to 2.1 cts. with squnre, and 2.1 to 2.3 cts. with hexagon nuts Chicago: Angle bars, 1.25 to 1.35 cts.; spikes, 1.7 to 1.8 cts.; track bolts, 2.1 to 2.2 cts., with hexagon nuts.

RAILS.—New York: $24 to $25 at eastern mills and at tide water; old rails, $11 to $11.50 for iron and $10 for steel; steel rails, fit for relaying, $16 to $16.50; light rails, $22 to $24; girder rails, $24. Pittsburg: $24 for standard sections. Chicago: $25 to $27; old rails, $10.50 to $11 for iron and $7.75 to $10 for steel.

STRUCTURAL MATERIAL.—New York: beams, 1.4 to 1.5 cts.; channels, 1.4 to 1.5 cts.; angles, 1.3 to 1.35 cts.; tees, 1.5 to 1.6 cts.; universal mill plates, 1.25 to 1.35 cts.; steel plates, 1.3 to 1.4 cts. for tank, 1.4 to 1.5 cts. for shell, 1.6 to 1.65 cts. for flange, 1.75 to 2 cts. for ordinary firebox, 2 to 2.25 cts. for locomotive firebox. Pittsburg: beams, 1.25 to 1.35 cts.; channels, 1.25 to 1.35 cts.; angles, 1.2 to 1.25 cts.; tees, 1.4 to 1.5 cts.; universal mill plates, 1.2 to 1.25 cts.; steel plates, 1.2 to 1.3 cts. for tank, 1.3 to 1.4 cts. for shell, 1.4 to 1.5 cts. for flange, 2.5 to 3 cts. for ordinary firebox, and 3.35 to 3.5 cts. for locomotive firebox. Chicago: beams, 1.45 to 1.5 cts.; channels, 1.45 to 1.5 cts.; angles, 1.4 to 1.45 cts.; tees, 1.65 cts.; universal plates, 1.4 to 1.45 cts.; steel plates, 1.45 to 1.5 cts. for tank, 1.5 to 1.6 cts. for shell, 1.65 to 2.1 cts. for flange, 1.65 to 5 cts. for firebox.

INDUSTRIAL NOTES.

THE OHIO FALLS CAR CO., of Jeffersonville, Ind., has resumed work with a force of 1,500 men on an order of 500 coal cars for the Pennsylvania R. R.

THE PITTSBURG REDUCTION CO. has opened an office in the Havemeyer Building, New York, with Jas. C. McGuire, late of the U. S. Treasury Department, Washington, as its New York agent. Mr. F. G. Bowles, of the Pittsburg office of the company, has also come to New York as assistant to Mr. McGuire.

THE SCHENECTADY LOCOMOTIVE WORKS, Schenectady, N. Y., are completing two powerful passenger engines for the Boston & Albany Ry. They are to haul the heavy Boston & Chicago limited express trains between Albany and Springfield, 163 miles, where there are grades as steep as 85 ft. per mile.

THE LAIDLAW-DUNN-GORDON CO., of Cincinnati, O., reports that the order for Park Bros. comprises two 30 × 60-in. gas compressors, to be driven by two 24 × 60-in. Corliss engines, the compressor cylinders being attached to the piston rod, which extends through the head of the steam cylinders. The capacity will be 90,000,000 ft. in 24 hours. This firm is also now building two 24 × 48-in. compressors for Findlay, O., to take the place of two recently given out, and it has also furnished quite a number for the natural gas region around about Pittsburg. The price received for the two from Park Bros. was $9,700, delivered on board cars, the firm not furnishing any pipe work, foundations or boilers.

THE NEW YORK DREDGING CO., World Building, New York city, announces that for land improvement or harbor improvement work it has some special machinery for the reclamation of low land by filling, and at the same time deepening the adjacent water front. All the work of excavation and conveyance is done at one time, and at one operation, by a single machine. The machine is also adapted for dredging and canal work. The company has recently executed work at the following places: Oakland, Cal.; Honolulu, Hawaiian Islands; Boston, Mass.; Jacksonville, Fla.; and Washington, D. C. It is claimed that the machines are so efficient that in many instances the work can be done at half the cost required by methods heretofore used. Mr. Geo. W. Catt, M. Am. Soc. C. E., is President and Engineer.

CAR WORKS.—A company composed of ex-employees of the Pullman Car Co., backed by Chicago capitalists, is said to have been organized to build car and general manufacturing shops at Hiawatha, Kan. Brown county citizens have taken $50,000 in stock and Chicago capitalists, $200,000. Pres., Louis Mayer; Secy., C. C. Allen. Mr. Allen is the inventor of a new palace sleeping car for which Mr. Pullman is said to have offered him $65,000, and a New York company $80,000 and a royalty. The company will be managed on the co-operative plan, each workman to receive a share of the profits, though the capitalists are guaranteed 6% on their investment before the laborer comes in for his share. The company has control of five patents and manufactures all kinds of railway equipment. Louis Meyer, President of the company, is the architect of the initial Pullman shops, and has been in the employ of that company ever since its organization.

NEW COMPANIES.—Appleby Bros. Co., Jersey City, N. J.; $2,500; to lay out streets and sewers, etc.; M. Du Bois Appleby and J. Randolph Appleby, Spotswood, N. J.—Russell Engineering Co., East St. Louis, Ill.; $30,000; Alfred Russell and Hedwig Russell.—Dominion Construction Co., Jersey City, N. J.; $500,000, all paid in; John N. Beckley, Rochester, N. Y.; Ephraim Miller, Plainfield, N. J.; James N. Young, Chicago, Ill.—Los Angeles Consolidated Oil Co., Los Angeles, Cal.; $10,000, with $1 paid in; Herbert G. Wylie, Lowery M. Smith and W. A. Calweil.

MUNICIPAL BOND MARKET.

New York, Sept. 4, 1894.

What characterizes the municipal bond market just now more than anything else is the presence of a large number of offerings of new municipal issues. This in itself is a good indication as to the improved condition of things. Not many sales are being reported, but that so many offerings are being made is good evidence that brokers and financial officers of municipalities believe that investors will soon again make their presence evident by subscribing to the new issues. There is Brooklyn to issue $1,500,000 new, $750,000 of which will go for water-works extension. Then Buffalo, N. Y., has for sale $150,000 3½ per cent. park bonds; Baltimore has just placed $500,000 3½ per cent. bonds; Cleveland, O., invites bids for $150,000 4 per cent. bonds; New Brunswick, N. J., has $100,000 long-time bonds for sale; Richmond, Va., will dispose of $225,000 4 per cent. bonds, etc. There is any number of smaller offerings from various municipalities, and the cry once heard during the summer, that the supply was unequal to the demand, will soon be hushed. The fact that the finance officials of the big cities will sell bonds now shows that they believe that good prices will be obtainable, and they are not likely to be disappointed. In fact prices all along have been extraordinarily good, as municipal bonds have been in sharp request all summer long, in contradistinction to the dearth of business in railroad bonds, and, in consequence, the dealers were enabled to place large amounts on a rising scale of prices. It is remarked particularly that the issues of cities and towns suitable for trust funds and savings banks of New York State have improved to an extent that they are now selling on a 3¼ to a 3½ per cent. basis.

One of the most successful bond sales of recent occurrence was that of the $100,000 5 per cent. 20-year Lansing, Mich., bridge and building bonds, which were sold to Blair & Co. at something around 109.2. Other bidders were Brewster, Cobb & Estabrook, who offered 109.170, and W. J. Hayes & Sons, who were willing to pay 109.027 for the bonds. These bonds were offered for sale once before, R. L. Day & Co. being found to be the highest bidders when bids were opened, although a delayed bid from Brewster, Cobb & Estabrook was higher. In consequence the bonds were reoffered, and, as a result of the bettered times, were sold as above at two points over the price previously bid by R. L. Day & Co. This is a good illustration as to the improved state of affairs that has developed within the past few weeks. As furnishing to contractors and other interested parties an index as to the credit of cities, the following quotations of current offerings are appended:

MUNICIPAL BONDS.

	Price.
County of Flathead, Mont., Gold 6s	107½
City of Bartow, Fla., 20-year 6s	102
City of Pana, Ill., Water 6s	105½
City of Bethany, Mo., Gold 6s	105¾
County of Park, Mont., Gold 6s	109¾
City of Moscow, Idaho, Gold 6s	102¾
City of Pullman, Wash., Gold 6s	103¼
City of St. James, Minn., 6s	107½
School District of Brainerd, Minn., 6s	108¾
County of Brazoria, Tex., 6s	103½
County of Taos, N. M., 6s	101
School District No. 6, Kings Co., 6s	107¾
City of Harriman, Tenn., 6s	102
City of Toledo, O., 5s	111½
City of Omaha, Neb., 5s	111
City of Portland, Ore., Gold 5s	112½
City of Galveston, Tex., 5s	101½
County of Vanderburgh, Ind., 5s	109½
City of Cheboygan, Mich., 5s	104
City of Ogden, Utah, 5s	103½
City of Parkersburg, W. Va., 6s	103¾
City of Brooklyn, N. Y., 4s	110¾
City of Marlboro, Mass., 4s	107
Town of Methuen, Mass., 4s	107
City of Waterbury, Conn., 4s	105½
City of Chicago, Ill., Gold 4s	104¾
City of Chicago, Drainage 5s, 1895	100½
" " " 5s, 1905	104½
" " " 5s, 1910	106¾
" " " 5s, 1914	107¾
City of Denver, Colo., Public Impvt 4s	100
Hamilton, O., 4½s	100.51
East Liverpool, O., 5s, 20-30 years	106.06
Belknap, 20-year, 4s	103.06
District of Columbia, 3.65s	113.406

RAILWAY STOCK MARKET.

New York, Sept. 4, 1894.

One should not judge the railway stock market of recent days altogether by the record of quotations. The juxtaposition of a half-holiday and two whole holidays has had the usual demoralizing effect, so far as the volume of transactions is concerned. It has also reacted to some extent upon the quality of the dealings, a more professional aspect than ever being lent to the trading by the momentary contraction of speculation. If one is to analyze present stock market conditions, the field of study is just now altogether outside of the Stock Exchange, as its doings largely fail to reflect the peculiar circumstances dominating the financial situation.

That the business affairs of this country are recovering from the blight laid on them by the long-continued uncertainty regarding the ultimate fate of the tariff legislation in progress till a few weeks ago, is no longer to be doubted. The long-wished for and patiently-awaited good times are now at hand. Mills are everywhere starting up again, once more are foundries blazing up, furnaces by the hundreds have been relighted; all the channels of commerce and trade are again being opened for the furtherance of business enterprises. That the railways must participate largely in this rejuvenation of business is palpable to all students of the country's economics. Interlaced as they are with every nature of the country's industries, no rehabilitation can progress without paying tribute largely to the messengers of commerce. In fact, reports of earnings show that railways have already begun to share in the revival. Gross earnings of 83 roads for the second week of August decreased 11 per cent., while those of 77 roads for the second week increased 3.52 per cent. A month ago decreases of 30 and 40 per cent. were being reported. Of course, net returns for the months preceding September must continue to show the bad results of labor troubles, ruined business and bad times in general, but from now on railway returns must make a flattering comparison not only with 1893, for that was a poor year, but with even the more gratifying record of 1892.

The railway stock market for the past ten days has been, on the whole, very strong. What weakness there has been was due probably more to liquidation for bull account than to any concerted effort on the part of bear operators to depress prices. True, it must be confessed that a deal more attention has been given in the Stock Exchange to the so-called industrials than to railroad stocks, but there has been sufficient active trading at times to determine the bias of Wall Street. The failure of most stocks to respond with a bound to the improved condition is not due so much to Wall Street disbelief in the genuineness of the revival as to the lack of outside interest in the stock market. Wall Street as a whole feels convinced that the country is rapidly leaving its commercial troubles behind, but so long as brokers have to live on scalping instead of commissions, then fluctuations will reflect only individual attempts to get a point or two out of the market.

The Southern Railway group has far eclipsed the rest of the list in strength. The South occupies to-day an undeniably favorable position, and Wall Street has been quick to recognize its solidity. What has attracted attention more than anything else to this group of roads has been the absolute success of the Richmond Terminal system. It is hardly right to apply that name with its ten-fold reminiscences of bankruptcies and receiverships, its internal fights, its broken hopes and promises. Out of the wreck of the demoralized and crumbling Richmond Terminal has arisen the Southern Railway, whole, united, sound, already prosperous. The success of the reorganization has been phenomenal. Some three dozen railways with interests at one time so interpreted as to be continually conflicting have been welded into one harmonious whole, under a single management that well know how to develop every dollar of resource to the system's benefit.

In keeping with the strength displayed by the old Richmond Terminal and new Southern Railway securities has been the activity shown by such stocks as Chesapeake & Ohio and Louisville & Nashville roads that are bound to profit by the same favorable circumstances that made the Southern Railway's success so possible. The Southwestern group, led by Missouri Pacific, is being helped along by the continued reports of material prosperity from that section of the country. The granger roads too show some improvement, the corn crop is not all gone, as Wall Street was once led to believe, and there will be plenty of business of other kinds to help along. The indications for a bull market continue as good as ever noted.

RAILWAY STOCK MARKET.

Railway stocks.	Closing prices Sept. 4.
Alton & Terre Haute	30
Atchison, Topeka & Santa Fe	8
Baltimore & Ohio	74⅜
Canada Southern	53¼
Chesapeake & Ohio	21½
Chicago, Burlington & Quincy	78⅜
Chicago & Northwestern	107
Chicago, Milwaukee & St. Paul	67¼
Chicago, Rock Island & Pacific	66¼
Cleveland, Cincinnati, Chicago & St. Louis	41½
Delaware, Lackawanna & Western	168½
Delaware & Hudson	134¾
Hocking Valley	19
Illinois Central	94¾
Lake Shore & Michigan Southern	136¼
Louisville & Nashville	56⅞
Missouri Pacific	30¼
Missouri, Kansas & Texas	15¾
Mobile & Ohio	21¼
New Jersey Central	113
New York Central	101¾
New York & New England, 3d asst. pd	27½
New York, New Haven & Hartford	181
New York, Chicago & St. Louis, 1st pfd	65
New York, Lake Erie & Western	16½
New York, Ontario & Western	17⅜
New York, Susquehanna & Western	16¾
Northern Pacific	5⅝
Northern Pacific, pfd	22¾
Philadelphia & Reading	22¾
Richmond Terminal	18¾
St. Paul & Omaha	38¾
Southern Pacific	20½
Texas Pacific	10½
Union Pacific	14
Wabash pfd	16⅞
Wheeling & Lake Erie	13¾

BOSTON RAILWAY STOCKS.

	Sept. 4.
Boston & Albany	208
Boston & Maine	147
Fitchburg, pfd	71
Old Colony	179½

PHILADELPHIA RAILWAY STOCKS.

	Sept. 4.
Lehigh Valley	39¾
Pennsylvania Railroad	52